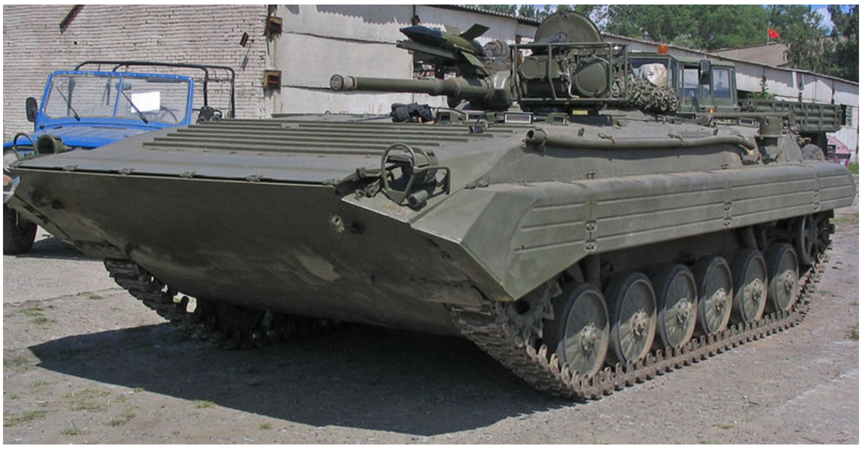
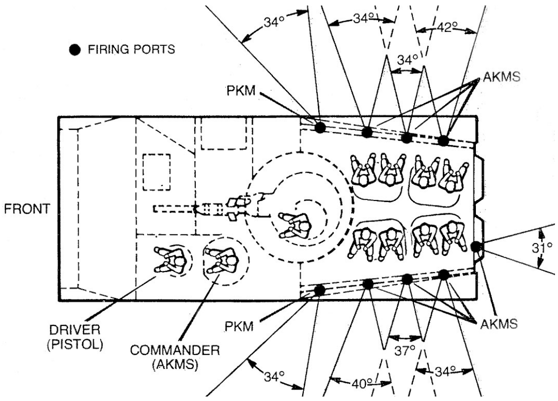
BMP-1 Fighting Vehicle

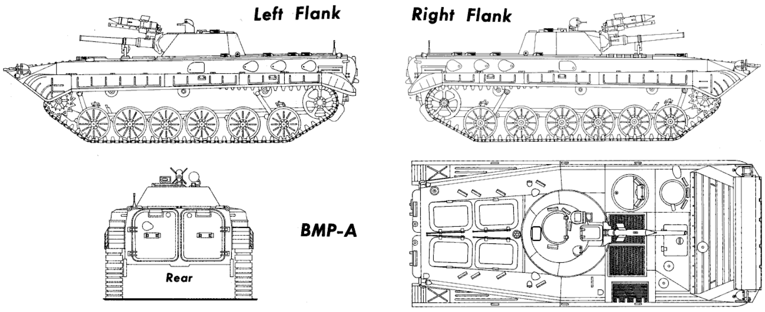
The Bronevaya Maschina Piekhota (BMP-1) literally "Combat Vehicle of the Infantry", was first built in the early 1960s and seen in public in November 1967 at a Red Square parade. The BMP represented an important shift from the concept of an armored personnel carrier to an armored infantry combat tank, combining high mobility, effective anti-tank weapons, and armored protection.

The BMP-1 was innovative in that it allowed the infantry being carried to fire their personal weapons from within the vehicle whilst remaining protected by armour. Thus the BMP became the first Infantry Fighting Vehicle (IFV).



Engine Type:	UTD - 20
Eng Layout:	V6 Quad Valve
Eng Starting Primary:	Air
Engine BHP:	300 BHP
Engine Displacement:	19,000 cc
Engine Torque:	100 kgm / 981 Nwm
Engine Bore x Stroke:	150 mm x 150 mm
Dimensions Length:	6,720 mm
Dimensions Width:	3,150 mm
Dimensions Height:	2,450 mm
Fuel consumption:	78 ltr / 100 km
Fuel Quantity:	480 Ltr
Fuel type:	Diesel
Trench clearance:	2,200 mm
Fording depth:	Amphibious
Max Road Speed:	65 kph
Max Off-Road Speed:	45 kph
Max ascent angle:	50 Degrees
Side slope:	33 Degrees
Vertical obstacle:	850 mm
Ground clearance:	480 mm
Ground pressure:	0.63 kg / cm2
NBC Air filtration:	Yes
Brakes Type:	Hydraulic
Track:	2,760 mm





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Inset 3 (Fig.71) between pages 122 and 123;
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Inset 6 (Fig.126) between pages 198 and 199;
Inset 7 (Figs 134, 135) between pages 208 and 209;
Inset 8 (Figs 148, 149) between pages 222 and 223;
Inset 9 (Fig.163) between pages 240 and 241;
Inset 10 (Fig.176) between pages 262 and 263;
Inset 11 (Fig.194) between pages 284 and 285;
Inset 12 (Fig.223) between pages 334 and 335;
Inset 13 (Fig.226) between pages 344 and 345;
Inset 14 (Fig.308) between pages 464 and 465;
Inset 15 (Fig.333) between pages 536 and 537.

INTRODUCTION

The present book contains the designation, description of the design and operating principle, rules of operation and adjustment of all assemblies, units and systems of the vehicle.

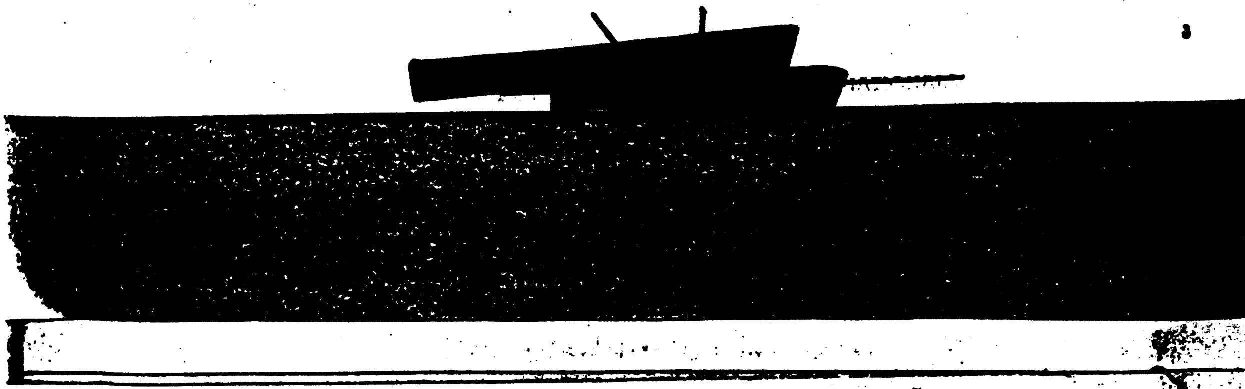
The book contains as well the rules of handling the vehicle weapons by the crew, the rules of the vehicle driving under different road and climatic conditions and when the vehicle is afloat, the sequence, procedure and timing of the vehicle maintenance.

The material of the book is intended for guidance of the specialists and the vehicle crew.

This book unites the material found in a number of technical descriptions and operating instructions on all main design elements of the infantry combat vehicle.

Listed below are the accepted abbreviations and designations.

АДУ - standard air pressure control unit
АЗС - automatic circuit breaker
АКМ - Kalashnikov submachine gun, modernized
БМП - infantry combat vehicle
ВЦН - fuel (gasoline) centrifugal pump
БС - bacteriological warfare agents
ВКУ - turret collector ring box
ВН - elevation
ГН - traversing
ГПК - gyro direction indicator
ДГН - traversing electric motor
ДВН - elevating electric motor
КР - relay box
КС - resistance box
КТ - triode box
КП - gearbox
МЗ (LM) - loading mechanism
МЗН - oil priming pump
МОД - engine shutdown mechanism
ОВ - toxic agents
ОМП - mass destruction weapon
ПАЗ - protection against atomic weapons
ПБЗ - antibacteriological protection
ПГ-15В - rocket-boosted hollow-charge projectile (round) for gun /antitank projectile/
ПК - Kalashnikov machine gun
ПКТ - Kalashnikov tank machine gun
ПМП - planetary steering gear
ПП - setting device
ППО - fire-fighting equipment



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ПУ - control panel
ПТУРС (ATGM) - antitank guided missile
ПХЗ - chemical defence
РВ - radioactive agents
СДУ - standard pressure warning unit
ТВНО-2 - driver's night vision device
ТГП - drive tachogenerator
ТДА - smoke-generating equipment
ТКН-3В - commander's night vision device
ТНПО-350Б - driver's vision device for observation when vehicle is afloat
ТНПО-170 - day vision device
ТПУ - tank interphone system
ТСГС - infrared homing head
ТХП - boresighting gauge
ФВУ - filter-ventilating unit
ФПТ - tank absorbent filter
ЭОП - image converter
2А28 - mark of smoothbore semi-automatic gun
1ПН22М1 - mark of periscopic sight
1ЭЦ10М - mark of electric elevating and traversing drive
9М14М - mark of antitank guided missile
9С428 - mark of antitank guided missile guidance system
9К32 - mark of portable antiaircraft missile system

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1. GENERAL DESCRIPTION AND SPECIFICATIONS

1.1. BRIEF INFORMATION ON DESIGN

Infantry combat vehicle БМП-1 (Figs 1 and 2) is a high-speed armoured vehicle, having good manoeuvrability and powerful armament.

The bullet-proof armour, spacious troop compartment, firing ports equipped with periscopic vision devices allow the troopers to conduct massed fire on the move.

The vehicle is equipped with 73-mm smoothbore gun 2А28, coaxial 7.62-mm machine gun ПКТ and a launcher for antitank guided missile (ATGM) 9М14М.

The vehicle features a system for protection from atomic, chemical and bacteriological weapons.

The infantry combat vehicle is adapted for transportation by air and may cross water obstacles afloat.

The vehicle lay-out is shown in Figs 3, 4 and 5. Arranged in the front part of the vehicle hull are: on the left - the driving compartment; on the right - the engine compartment, the hull middle part is occupied by the fighting compartment. The troop compartment is located in the vehicle rear.

Arranged in the driving compartment (Fig. 6) are:

- driver's and commander's seats;
- driver's central panel;
- controls of the power transmission and power plant;
- the cock of the interlocked control of the air intake pipe, splash panel and dust suction valve of the air cleaner;
- the compressed air cylinder;
- gyro direction indicator ГПК-59;
- radio station Р-123М with the supply unit;
- supply unit of the driver's night vision device;
- interphone control box А-1;
- tank of the vision devices air-liquid cleaning system;
- the special blower, valve box and absorbent filter ФПТ-200М;
- heater of the filter-ventilating unit;
- signal lamps, switches, panels, valves, switch buttons and auxiliary devices. Purpose of the switches and buttons is indicated on the nameplates, secured under them.

Provided in the front part of the driving compartment (Fig. 7) is a bay, accommodating: the steering column with the shifter shaft box, radio interference filter, horn, splash panel pneumatic control cylinder, relay box КР-40, gyro direction indicator converter and relay box КР-65.

Arranged in the engine compartment (Fig. 8) are the power plant and power transmission assemblies with their systems.

Located in the engine compartment front part under the front ribbed plate are the assemblies of power transmission and hydraulic control, control rods and levers, water drain-

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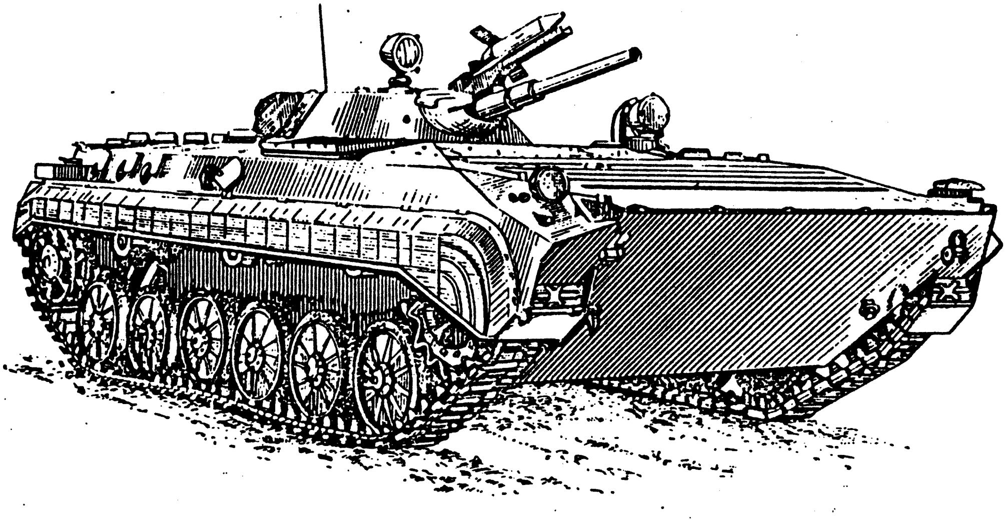

FIG. 1. INFANTRY COMBAT VEHICLE (RIGHT FRONT VIEW)

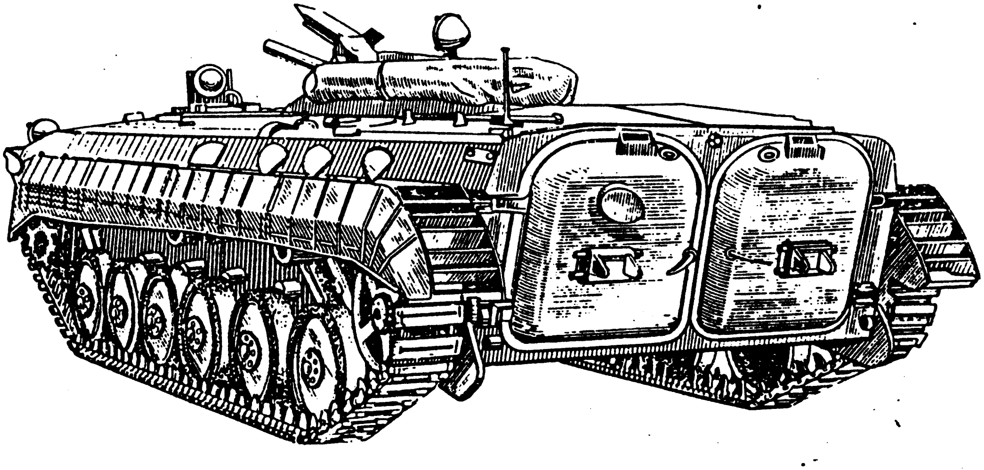

FIG 2 INFANTRY COMBAT VEHICLE (RIGHT REAR VIEW)

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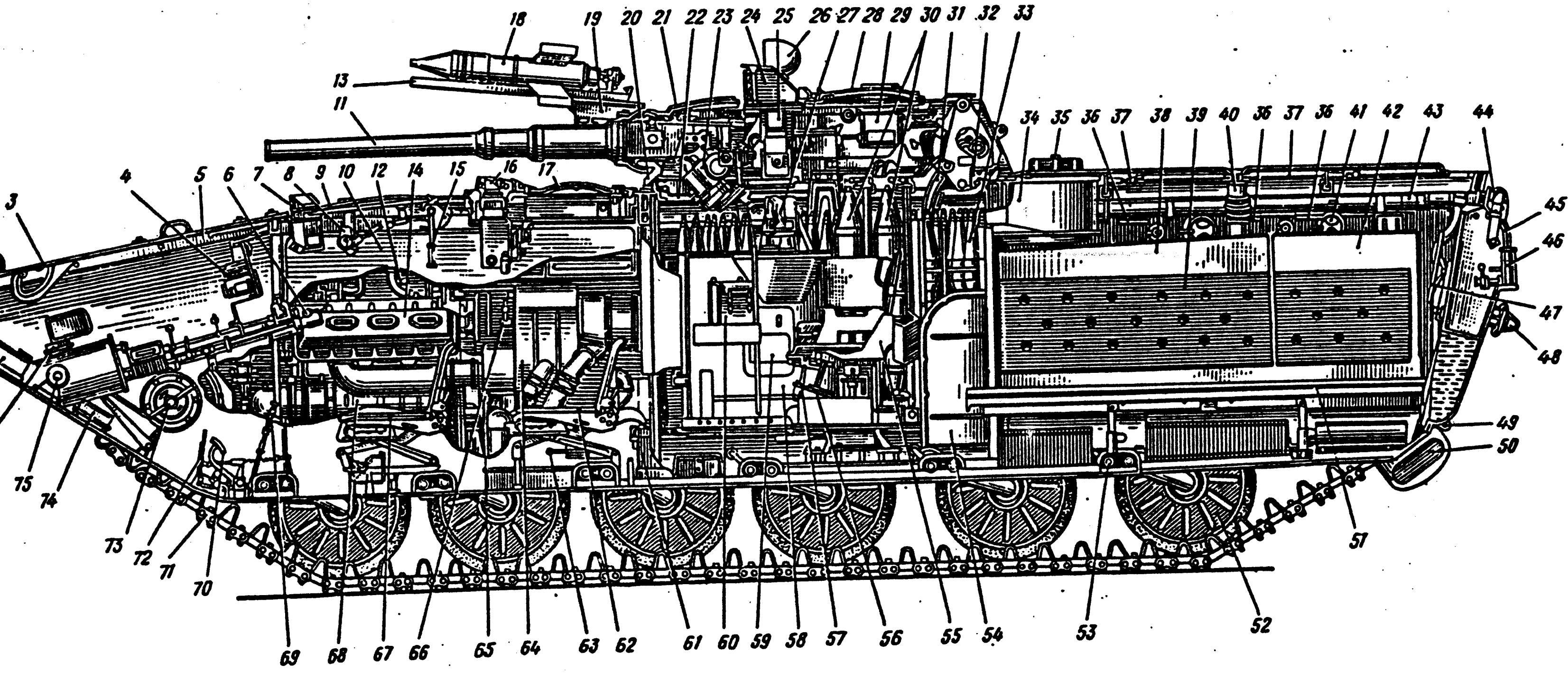

FIG.3. INFANTRY COMBAT VEHICLE (LONGITUDINAL SECTION)

1 - lower sloping plate; 2 - splash panel; 3 - front ribbed plate; 4 - driver's central panel; 5 - longitudinal beam; 6 - steering handle bar; 7 - driver's vision device ТНПО-170; 8 - driver's hatch door lock; 9 - driver's hatch door; 10 - engine compartment bulkhead; 11 - gun 2A28; 12 - filling tank of engine lubrication system; 13 - ATGM guide rail; 14 - engine УТД-20; 15 - louvres and ejector shutters control handle; 16 - commander's vision drvice ТКН-3Б; 17 - commander's hatch door; 18 - missile 9M14M; 19 - launching bracket; 20 - turret; 21 - ATGM feed hatch; 22 - toothed rim of turret lower race; 23 - gun elevating mechanism; 24 - sight head; 25 - sight; 26 - headlight ФГ-126; 27 - laying control panel; 28 - operator's hatch door; 29 - operator's device ТНПО-170; 30 - missiles 9M14M on guide rails; 31 - round feed mechanism levers; 32 - turret upper race; 33 - rounds in conveyer; 34 - air duct; 35 - air intake pipe; 36 - troop compartment vision devices; 37 - troop compartment hatch door; 38 - fuel tank; 39 - troop seat back; 40 - fuel tank filler neck; 41 - firing port vision glass; 42 - storage battery compartment; 43 - antiaircraft system 9K32; 44 - rear vision divice ТНПО-170; 45 - rear door; 46 - rear ball support for firing submachine gun; 47 - rear-door lock handwheel; 48 - spare track shoe; 49 - eye ring for attachment of vehicle in aircraft; 50 - track pin driving cam; 51 - troop seat; 52 - road wheel; 53 - torsion bar; 54 - conveyer guard; 55 - operator's seat; 56 - ATGM control panel (in travelling position); 57 - handle for locking of ATGM control panel in travelling and combat positions; 58 - empty case-and-link collector; 59 - empty case-and-link collector cover; 60 - bag for headset; 61 - SPTA box; 62 - commander's seat; 63 - fuel cock handle; 64 - air cleaner; 65 - housing of power takeoff shaft to compressor; 66 - handwheel of ejector shutter control linkage; 67 - driver's seat; 68 - generator ВГ-7500; 69 - fuel feed manual control lever; 70 - engine clutch pedal; 71 - track; 72 - fuel feed pedal; 73 - planetary steering gear-to-left final drive connecting shaft; 74 - relay box КР-40; 75 - converter of gyro direction indicator; 76 - relay box КР-60; 77 - radio interference filter Ф-1; 78 - horn; 79 - towing hook

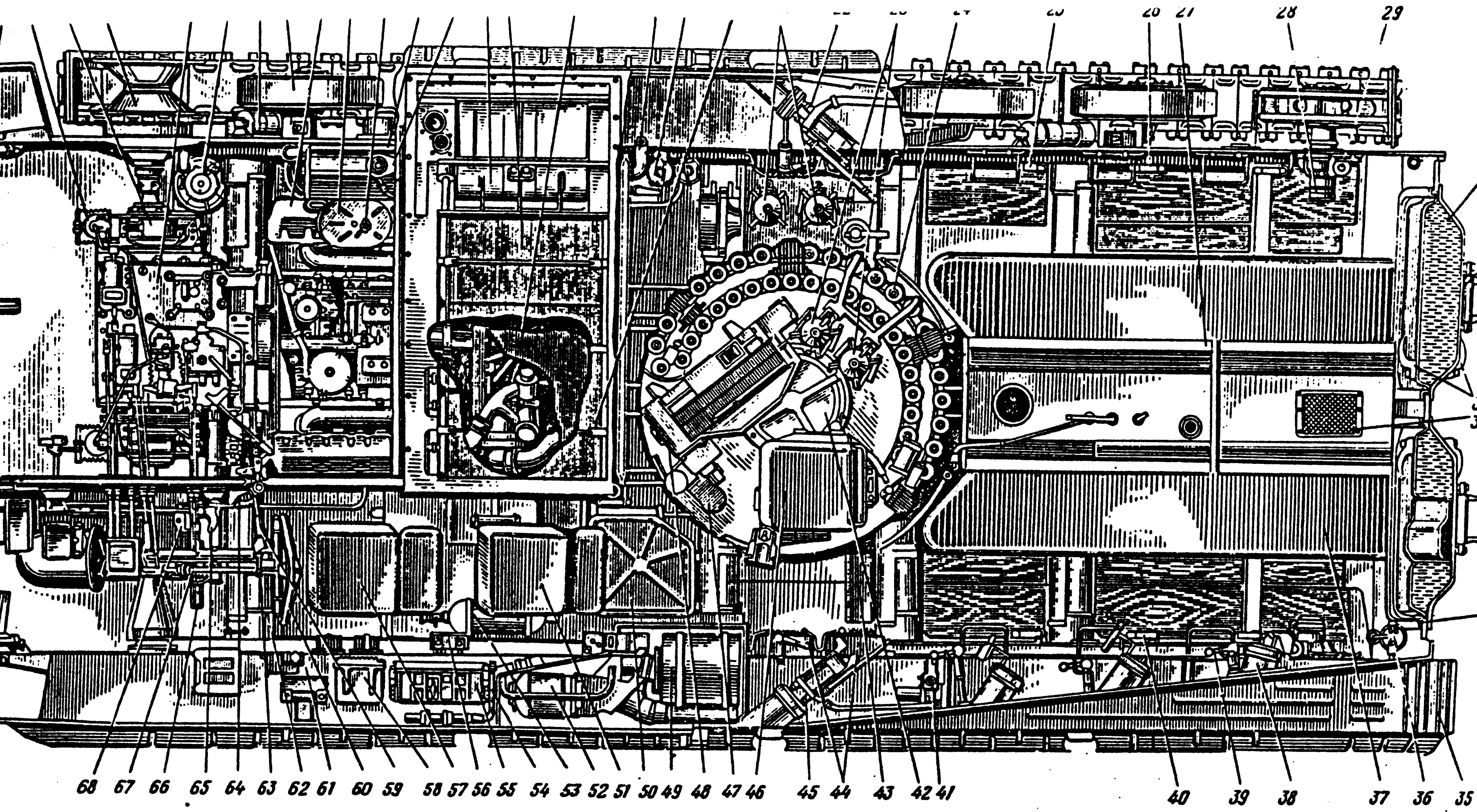

FIG.4. INFANTRY COMBAT VEHICLE (TOP VIEW WITH ROOF REMOVED)

1 - power plant attachment brackets; 2 - splash panel pneumatic cylinders; 3 - stopping brake hydraulic cylinder; 4 - planetary steering gear; 5 - driving sprocket; 6 - gearbox; 7 - front water drainage pump; 8 - hydraulic shock absorber; 9 - road wheel; 10 - engine; 11 - cooling system expansion tank; 12 - vacuum and pressure relief valve; 13 - oil tank of engine lubricating system; 14 - filling tank of lubricating system; 15 - cooling system ejector; 16 - oil cooler of engine lubricating system; 17 - engine cooling system radiator; 18 - pipeline to drain water pumped by pump with mechanical drive; 19 - cylinder of fire-fighting equipment; 20 - power transmission oil cooler; 21 - ATGM stowage in vehicle hull; 22, 45 - ПК machine gun supports; 23 - ATGM stowage place in turret; 24 - round in conveyer; 25, 26, 40 - brackets for securing submachine guns in travelling position; 27 - fuel tank; 28 - idler wheel crank axle; 29 - worm of track adjusting mechanism; 30 - fuel tank in rear door; 31 - spare track shoe; 32 - rear door handles; 33 - net of troop compartment heater fan; 34 - rear door rubber packing; 35 - guide vanes; 36 - portable fire extinguisher ОУ-2; 37 - troop seat; 38 - submachine gun ball support; 39 - handle of firing port armour cover; 41 - blower sucking powder gases from vehicle; 42 - turret collector ring box; 43, 44 - machine gun ammunition boxes; 46 - operator's seat; 47 - gun elevating mechanism; 48 - empty case-and-link collector; 49 - absorbent filter; 50 - box for headsets; 51 - commander's seat; 52 - special blower; 53 - compressed air cylinder; 54 - special blower air distributing pipeline; 55 - radio station; 56 - commander's control box No. 1; 57 - driver's seat; 58 - radio station supply unit; 59 - gear shift lever; 60 - steering handle bar; 61 - bay lower plate; 62 - hull transverse beam; 63 - low range engagement lever; 64 - manual fuel feed control linkage; 65 - parking brake control handle; 66 - engine clutch pedal; 67 - stopping brake pedal; 68 - fuel feed pedal; 69 - splash panel control pneumatic cylinder; 70 - radio interference filter; 71 - horn

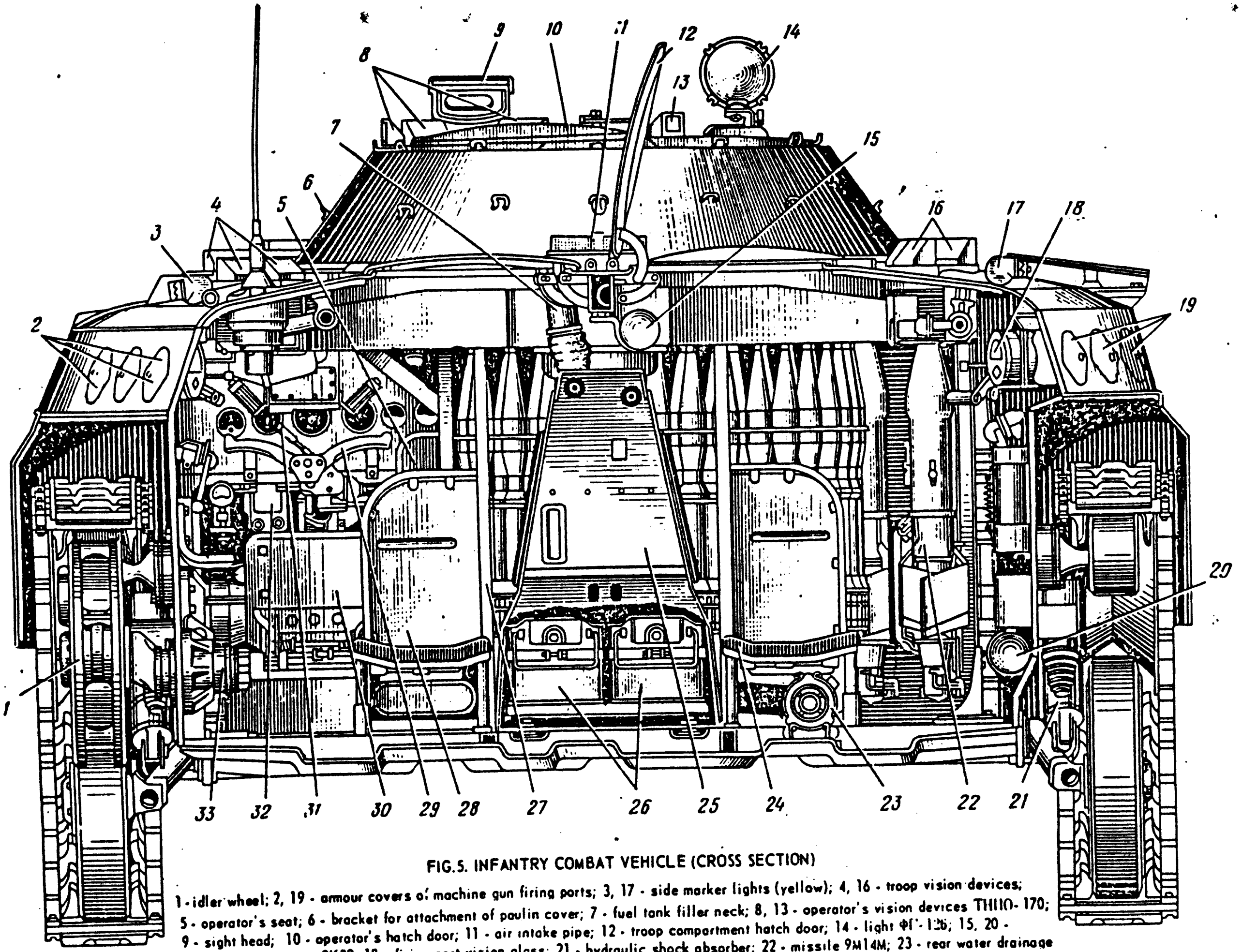

FIG.5. INFANTRY COMBAT VEHICLE (CROSS SECTION)

1 - idler wheel; 2, 19 - armour covers of machine gun firing ports; 3, 17 - side marker lights (yellow); 4, 16 - troop vision devices;
5 - operator's seat; 6 - bracket for attachment of paulin cover; 7 - fuel tank filler neck; 8, 13 - operator's vision devices ТНПО- 170;
9 - sight head; 10 - operator's hatch door; 11 - air intake pipe; 12 - troop compartment hatch door; 14 - light ФГ-126; 15, 20 -
antiaircraft systems 9K32; 18 - firing port vision glass; 21 - hydraulic shock absorber; 22 - missile 9M14M; 23 - rear water drainage
pump and smoke-generating equipment pump; 24 troop seat; 25 - rear wall of storage battery section; 26 - storage batteries; 27 - strut;
28 - conveyer guard; 29 - steering handle bar; 30 - commander's seat backrest; 31 - low range engagement lever; 32 - gyro direction indicator ГПК 59; 33 - track adjusting mechanism

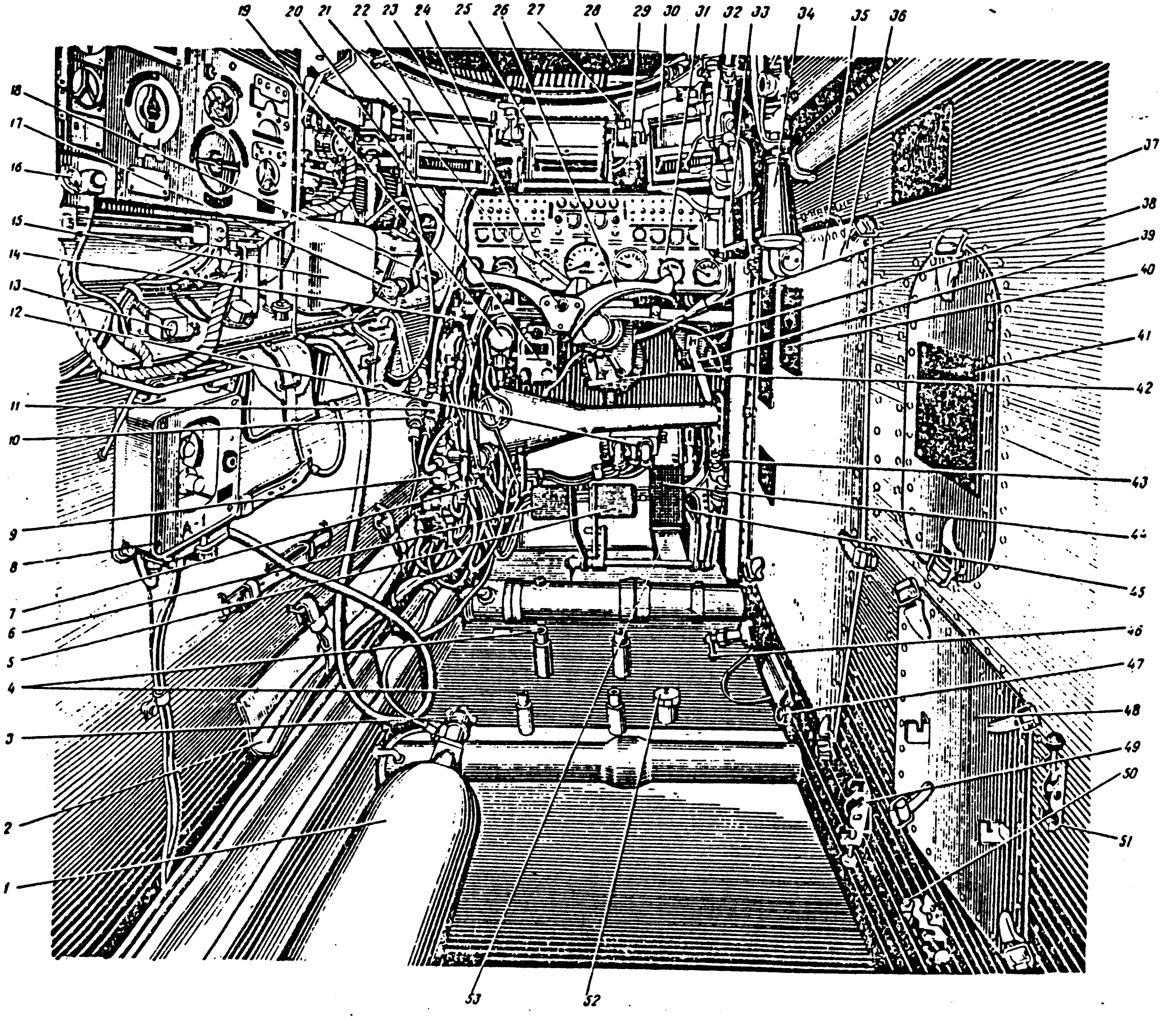

FIG.6. DRIVING COMPARTMENT

1 - compressed air cylinder; 2 - bag with flags; 3 - cylinder valve; 4 - driver's seat attachment brackets; 5 - stopping brake pedal; 6 - engine clutch pedal; 7 - breast switch cable; 8 - interphone control box A-1; 9 - interlocked pneumatic control valve handle; 10 - electropneumatic valve of engine air starting system; 11 - electropneumatic valve of vision devices air-liquid cleaning system; 12 - relay box KP-40; 13 - air-liquid cleaning panel; 14 - splash panel control cock handle; 15 - tank of air-liquid cleaning system; 16 - radio station; 17 - plug connector of high-voltage power pack of device TBHO-2; 18 - pilot lamp CLOSE HATCHES; 19 - pneumatic system pressure gauge; 20 - gyro direction indicator; 21 - horn button; 22 - L.H. vision device; 23 - vision device attachment; 24 - low range engagement lever; 25 - middle vision device; 26 - steering handle bar; 27 - hull roof; 28 - driver's hatch; 29 - end piece of air supply pipe from filter-ventilating unit; 30 - R.H. vision device; 31 - control panel; 32 - handle for opening of engine water protection mechanism valves; 33 - handle of driver's hatch opening mechanism; 34 - louvres control handle; 35 - cover of engine compartment bulkhead hatch; 36 - cover lock; 37 - gear shift lever; 38 - retainer of parking brake handle; 39 - parking brake handle; 40 - instruction plate; 41 - cover of engine compartment bulkhead hatch; 42 - control rod; 43 - manual fuel feed control handle; 44 - fuel feed pedal; 45 - return spring; 46 - cock for removal of condensate from oil-and-moisture separator; 47 - cock of preheater fuel feed system; 48 - cover of engine compartment bulkhead hatch; 49 - cock for draining of coolant from engine cooling system; 50 - cock of engine fuel system; 51 - cock of preheater air shutter; 52 - drain valve of engine cooling system; 53 - pedal bridge

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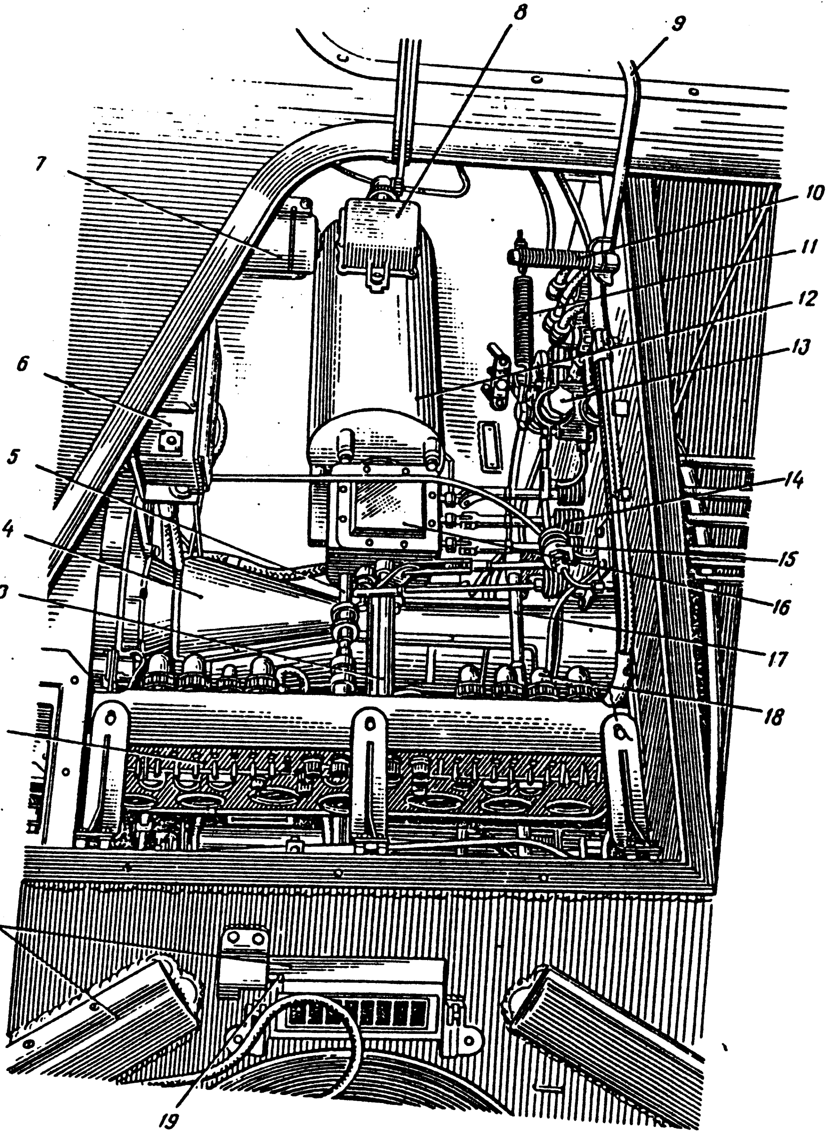

FIG.7. DRIVING COMPARTMENT FRONT SECTION (TOP VIEW)

1 - driver's vision devices; 2 - driver's central panel; 3 - steering column; 4 - casing of L.H. final drive shaft; 5 - gear shift control shaft; 6 - relay box KP-40; 7 - converter of gyro direction indicator; 8 - relay box KP-65; 9 - retainer of ribbed plate in open position; 10 - retainer spring; 11 - return spring of parking brake control; 12 - tubular bracket for attachment of shifter shaft box; 13 - reducer of pneumatic system; 14 - corrugated rubber pipe for sealing the hole for passage of control rod; 15 - air filter; 16 - shifter shaft box; 17 - parking brake control shaft; 18 - plug connectors; 19 - nozzle of vision device air-liquid cleaning system

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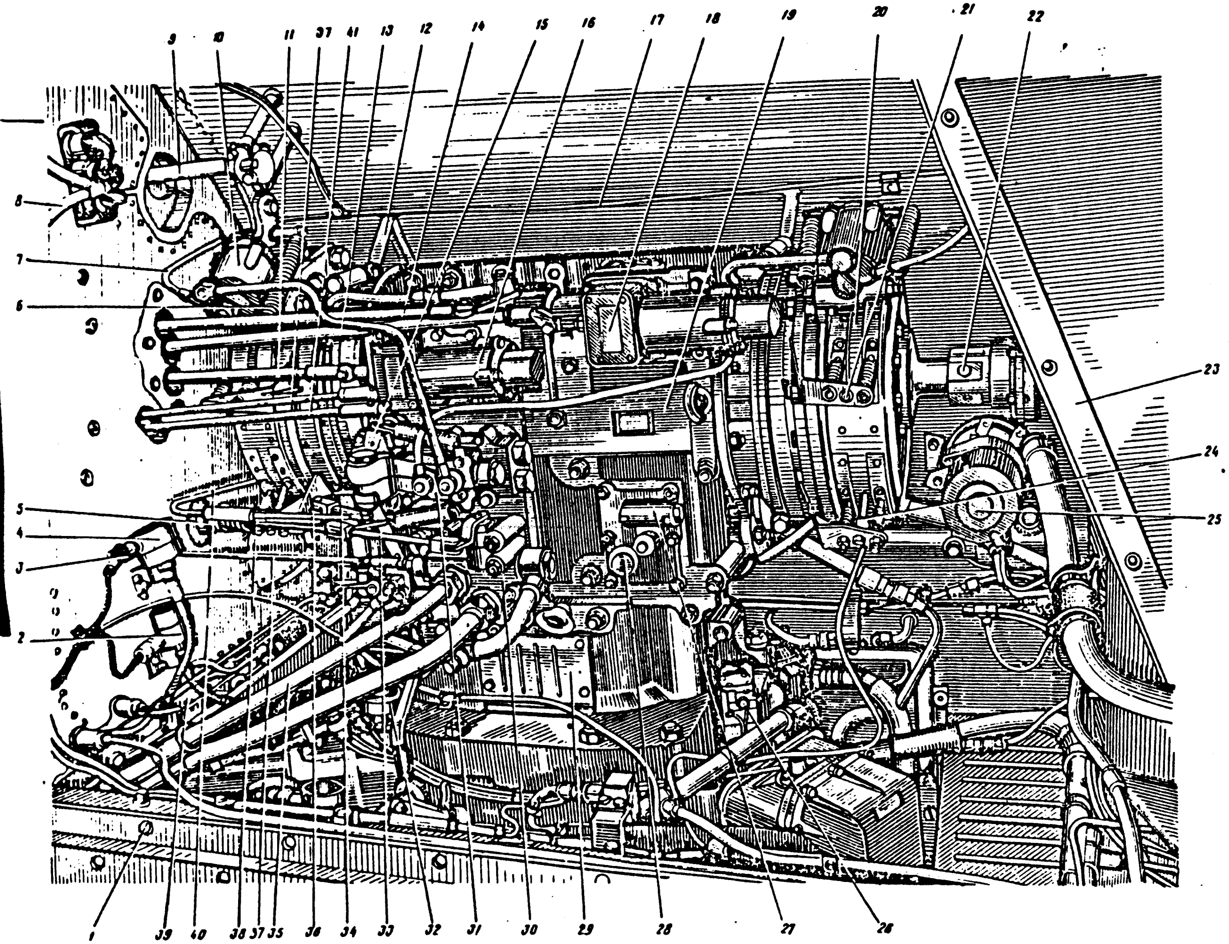

FIG.8. ENGINE COMPARTMENT (TOP VIEW OF POWER TRANSMISSION)

1 - hole for ribbed plate attaching bolt; 2 - pressure warning unit; 3 - plug connector; 4 - sending unit of power transmission lubricating system pressure gauge; 5 - control rod packing; 6 - spring; 7 - oil pipeline; 8 - electric cables; 9 - parking brake control bridge; 10 - L.H. stopping brake hydraulic cylinder; 11 - gear shift control rod of 2nd and 3rd gears; 12 - base of power plant attachment hoop; 13 - gear shift control rod of 4th and 5th gears; 14 - gear shift control rod of 1st and reverse gear; 15 - lever of left turn slide valve; 16 - hydraulic servocylinder of 2nd and 3rd gears; 17 - compressed air pipeline to hydraulic cylinders; 18 - hydraulic servocylinder of 4th and 5th gears; 19 - gearbox; 20 - R.H. stopping brake band; 21 - bracket for attachment of brake band return springs; 22 - semi-rigid connection coupling; 23 - gasket of front ribbed plate; 24 - brake band adjusting nut; 25 - front water drainage pump; 26 - engine tachogenerator; 27 - engine clutch smooth engagement valve; 28 - gearbox filler plug; 29 - engine clutch housing access hole cover; 30 - valve box of power transmission hydraulic control system; 31 - slide box of power transmission hydraulic control system; 32 - sending unit of engine lubricating system pressure gauge; 33 - engine clutch control rod; 34 - stopping brake control rod; 35 - hydraulic control system oil pipelines; 36 - hydraulic vortex tube; 37 - low range control rods; 38 - R.H. planetary steering gear control rod; 39 - control cable of engine water protection mechanism valves; 40 - compressed air supply pipe to engine clutch pneumatic control system; 41 - L.H. planetary steering gear control rod

[redacted]

age pump and the pipelines of the hydraulic control, lubrication and compressed air systems.

The engine and its systems are arranged in the engine compartment rear part.

Mounted there as well are the compressor, water drainage pump and the compressor fan.

The engine, engine clutch, gearbox and planetary steering gears are united in one unit. The components of the engine cooling system and the air cleaner are also arranged in one unit.

Mounted in the fighting compartment (Figs 9 and 10) are:

- operator's seat with ATGM control panel;
- the armament with laying drives and sighting and vision devices;
- the gun loading mechanism with a conveyer for 40 rounds;
- two stowage places for four missiles 9M14M;
- two cylinders of fire-fighting equipment ППО;
- the blower for suction of gases from the fighting compartment.

The fighting compartment is located under the rotating turret having the rotating platform.

Arranged in the troop compartment (Fig. 11) are:

- two seats for eight troopers;
- three fuel tanks;
- two storage batteries;
- troop compartment heater;
- electrical equipment units;
- boxes for food-stuffs and SPTA;
- water drainage pump and pump of smoke-generating equipment;
- the blowers for suction of powder gases from the troop compartment;
- firing ports for small arms firing.

1.2. COMBAT AND PERFORMANCE CHARACTERISTICS

1.2.1. General

Type of vehicle	track-laying armoured amphibious
Mark	BMП-1
Combat mass, t	13.0-13.3
Personnel:	
crew	3 men
troop	8 men
Specific ground pressure, kgf/cm^2	0.60-0.61
Specific power, hp/t	21.5-23.1

1.2.2. Basic Dimensions, mm

Length	6735
Width, overall	2940
Width with fenders raised (during air transportation)	2850
Out-to-out track width	2850
Height, overall	2068
Track	2550
Length of track bearing surface	3600
Road clearance	370 (min.)

1.2.3. Rated Speeds, km/h (at 2600 rpm of engine crankshaft)

When high range is engaged:

1st gear	10.6
2nd gear	19.6

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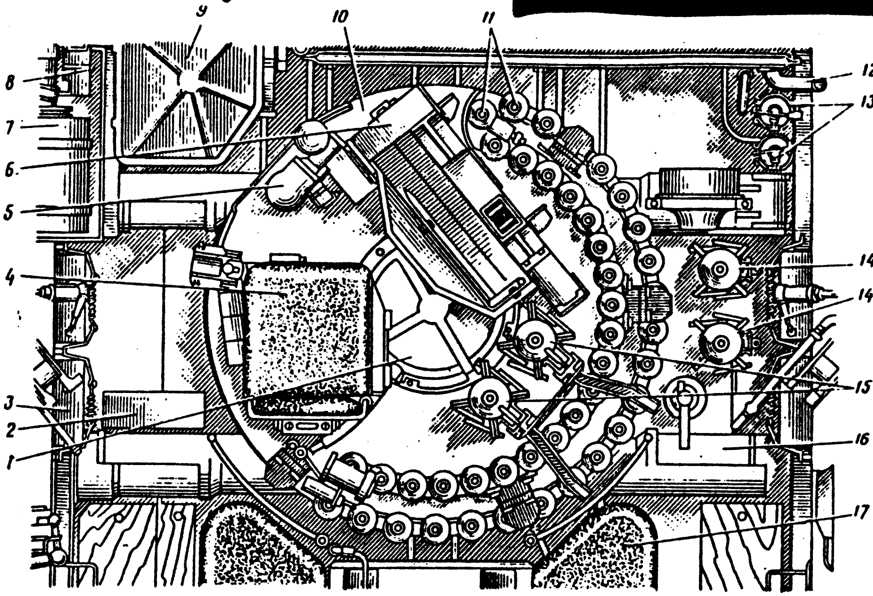

FIG.9. FIGHTING COMPARTMENT (TOP VIEW)

1 - turret collector ring box; 2, 3 - ammunition boxes for machine gun ПК; 4 - operator's seat; 5 - gun elevating mechanism; 6 - empty case-and-link collector; 7 - absorbent filter; 8 - lower plate of L.H. bay; 9 - box for headsets; 10 - turret rotating floor; 11 - gun rounds; 12 - middle water drainage pump pipeline; 13 - cylinder of fire-fighting equipment ППО; 14, 15 - ATGM; 16 - vehicle bottom lateral beam; 17 - troop seat

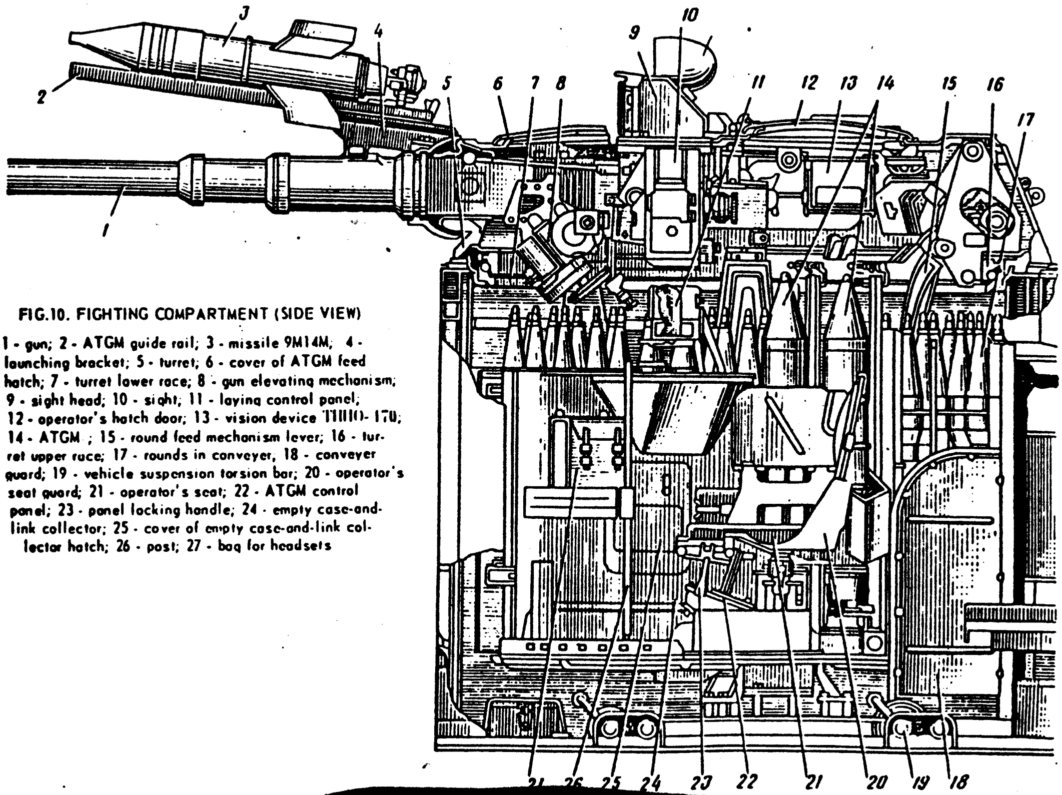

FIG.10. FIGHTING COMPARTMENT (SIDE VIEW)

1 - gun; 2 - ATGM guide rail; 3 - missile 9M14M, 4 - launching bracket; 5 - turret; 6 - cover of ATGM feed hatch; 7 - turret lower race; 8 - gun elevating mechanism; 9 - sight head; 10 - sight; 11 - laying control panel; 12 - operator's hatch door; 13 - vision device ТНПО-170; 14 - ATGM ; 15 - round feed mechanism lever; 16 - turret upper race; 17 - rounds in conveyer, 18 - conveyer guard; 19 - vehicle suspension torsion bar; 20 - operator's seat guard; 21 - operator's seat; 22 - ATGM control panel; 23 - panel locking handle; 24 - empty case-and-link collector; 25 - cover of empty case-and-link collector hatch; 26 - post; 27 - bag for headsets

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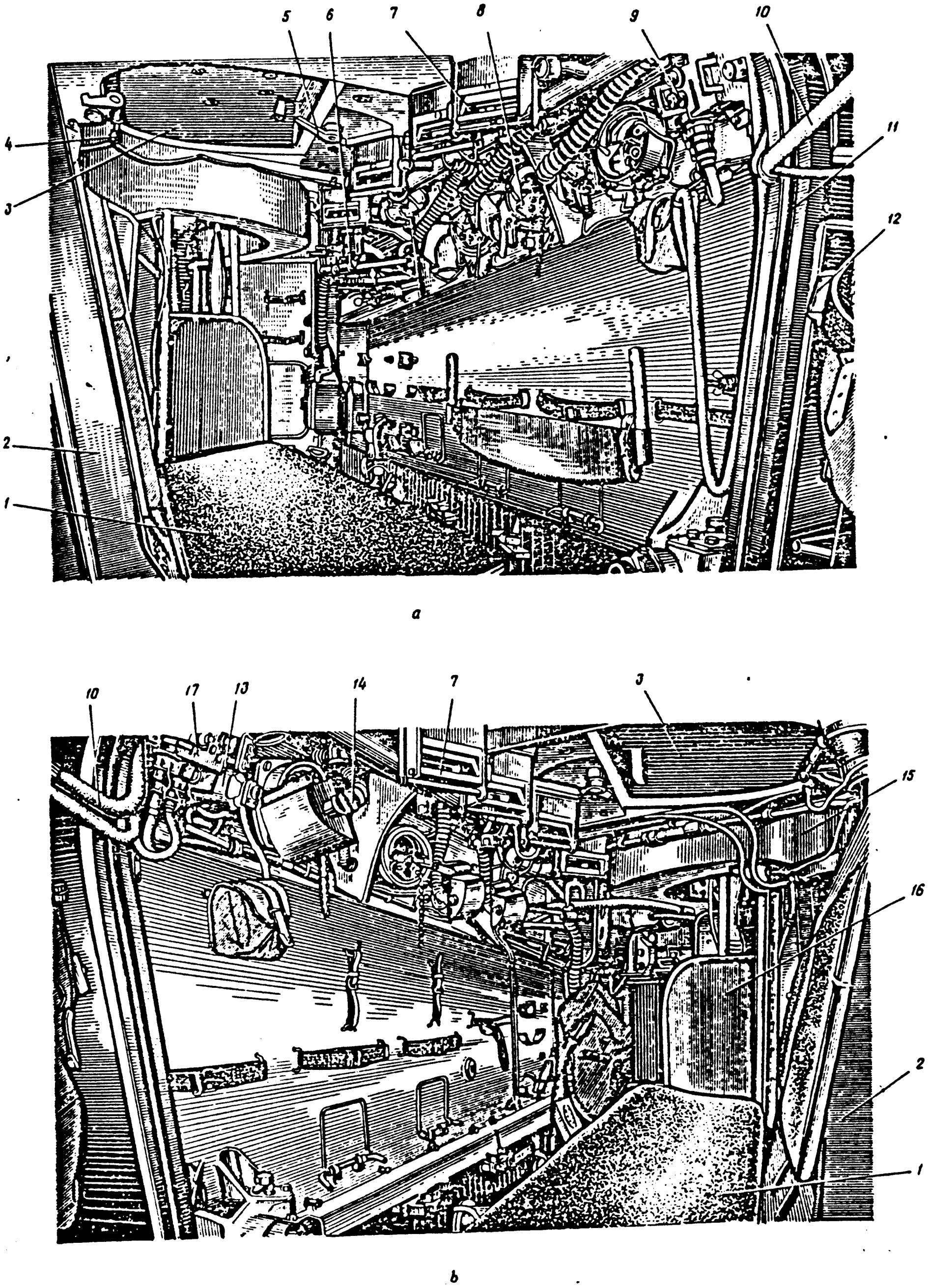

FIG.11. TROOP COMPARTMENT (REAR VIEW)

a - troop compartment right section; b - troop compartment left section
1 - troop seat; 2 - storage battery bay; 3 - troop compartment hatch door; 4 - hatch door lock; 5 - hinge; 6 - machine gun support; 7 - vision device; 8 - submachine gun ball support; 9 - box KP-60 for switching on heating of vehicle right side vision devices; 10 - flexible fuel hose; 11 - door gasket; 12 - door hinge; 13 - interphone control box; 14 - ventilating system corrugated branch pipe; 15 - annular air duct; 16 - fighting compartment guard; 17 - box for switching on heating of vehicle left side vision devices glasses

[redacted]

3rd gear ...
4th gear ...
5th gear ... 29.1
reverse gear ... 43.3
When low range is engaged: ... 65.0
1st gear ... 10.6
2nd gear ...
3rd gear ... 7.3
4th gear ... 13.6
5th gear ... 22.0
reverse gear ... 30.0
Average speed on dry country road ... 45.1
Maximum speed ... 7.3
on highway ... 40.0-45.0
on water:
forward motion ... 65.0
reverse motion ...
... 7.0 (min.)
... about 2.0

1.2.4. Fuel and Oil Consumption, Fuel Distance

Mean fuel consumption per 100-km run, l:
on highway ...
on dry country road ... 77-84
Mean fuel consumption during 1 hour of engine operation, l: ... 80-112
on highway ...
on dry country road ... 31-38
Mean oil consumption per 100-km run, l ... 28-40
Fuel distance, km: ... 2.8
on highway ...
on dry country road ... 550-600
... 400-570

1.2.5. Negotiable Obstacles

Maximum negotiable upgrade (depending on engine power), deg ... 35
Width of ditch, m ... 2.5
Maximum vertical object negotiable, m ... 0.7
Maximum steepness of descent into water and climb out of water, deg:
in above-water part ...
in under-water part ... 25-30
Maximum permissible speed of current in negotiated water ... 15
obstacle, m/s ...
... 1.2

1.2.6. Armament

Gun

Type ...
Mark ... smoothbore semiautomatic
Caliber, mm ... 2A28
Rate of fire, rounds per min ... 73
Range of aimed fire, m ... 8-10
Direct fire range at 2-m high target, m ... 1300
... 765

[redacted]

Loading	by semiautomatic loading mechanism
Recoil length, mm	up to 150

Coaxial Machine Gun

Number	one
Type	ПКТ
Caliber, mm	7.62
Mark	tank
Machine gun feeding	belt type
Practicable rate of fire, rounds per min	200-250

ATGM System

Type of guidance system	single-channel guidance system, with control over wires
Mark of guidance system	9C428
Missile guided flight range, m:	
maximum	3000
minimum	500

Armament Kept in Stowage Places

Machine guns ПК	2
Submachine guns АКМ	7
Hand grenades Ф-1	10
Signal pistol	1

Gun Loading Mechanism

Type	conveyer type, with electromechanical drive
Number of rounds in conveyer	40

Laying Drives of Coaxial Mount

Type of main drives	electromechanical, with impulse regulation of rate of laying
Type of duplicate drives	MECHANICAL, with manual control
Mark of laying electric drive	13Ш10М
Rate of coaxial mount traverse when laying by electric drive, deg/s:	
maximum	not less than 20
minimum	not more than 0.1
Rate of gun elevation, deg/s:	
maximum	not less than 6.0
minimum	not more than 0.07
Rate of coaxial mount laying by manual drive, in degrees per one revolution of handwheel	1

Firing Ports for Firing Troop Small Arms

Number:	
for machine guns ПК	2

[redacted]

for submachine guns AKM 7

Fire Angles from Coaxial Mount, deg:

Horizontal angle ....
Elevation angle 360
Depression angle .... +30
.... -4

Ammunition

Gun rounds:
  mark ....
  number ПГ-15В
  mass of one round, kg 40
Cartridges for coaxial machine gun, pcs 3.47
Cartridges for side machine guns ПК 2000
Missiles of ATGM system:
  mark 2400
  number 9M14M
  mass of one missile, kg 4
Flares for signal pistol 10.9
.... 12

1.2.7. Sighting and Vision Devices

Sight

Type ....
.... periscopic,
combination
(day and night
Mark .... passive)
Periscopic height, mm 1ПН22М1
Magnification, times: 230
  of day system ....
  of night system 6
Field of view, deg: 6.7
  of day system ....
  of night system 15
Visibility range at night, m 6
.... 400 (with locality lighting of 0.003-0.005 lux and normal transparency of the atmosphere)

Combination Commander's Vision Device

Type ....
.... electron-optical, periscopic, binocular, combination (day and active
Mark .... night)
Periscopic height, mm TKH-3B
.... 200

[redacted]

Viewing angles, deg:	
in horizontal plane	270
in vertical plane	16
Magnification, times:	
of day system	5
of night system	4.2
Field of view, deg:	
of day system	10
of night system	8
Visibility range, m	300-400
Infrared light source	spotlight ОУ-3ГА2

Day Prismatic Vision Device of the Crew and Troopers

Type	periscopic, prismatic, with electric heating
Mark	ТНПО-170
Number	19
Periscopic height, mm	153
Field of view, deg:	
in horizontal plane	44
in vertical plane	6.5
Viewing angles, deg:	
in horizontal plane	not less than 94
in vertical plane:	
elevation	not less than 12
depression	not less than 11

Driver's Night Vision Device

Type	electron-optical, binocular, periscopic, with infrared light source
Mark	ТВНО-2
Number	1
Periscopic height, mm	212
Field of view, deg	30
Visibility range, m	not less than 50 (at normal atmospheric transparency)
Infrared light source	headlight ФГ-125
Power pack	BT-6-26

Day Vision Device for Driving Water-Borne Vehicle

Type	periscopic, prismatic, with electric heating
Mark	ТНП-350Б
Number	1

[redacted]

in horizontal plane	42
in vertical plane:	
elevation	5
depression	6

1.2.8. Gyro Direction Indicator

Type	navigation, gyroscopic
Mark	ГПК-59
Time passing before another orientation of device is required, min	60

1.2.9. Power Plant

Engine

Type	diesel, four-stroke, airless-injection, liquid-cooled, with direct injection of fuel
Mark	УТД-20
Number of cylinders	6
Arrangement of cylinders	V-shaped, with 120° angle between banks of cylinders
Diameter of cylinder, mm	150
Piston stroke, mm	150
Displacement of engine cylinders, l	15.9
Compression ratio	15.8
Maximum power at 2600 rpm, hp	300^{-15}
Maximum torque at 1500-1600 rpm, kgf·m	100^{+5}_{-10}
Firing order of cylinders	1st L.H.-1st R.H.-2nd L.H.-2nd R.H.-3rd L.H.-3rd R.H.
Order of cylinders numbering	from the side opposite to flywheel (engine clutch)
Recommended engine service speed, rpm	1800-2400
Maximum engine speed limited by governor at idle running, rpm	2850
Minimum stable idle speed, rpm	600-700
Specific fuel consumption at maximum power duty, g/hp·h	not more than 175
Specific consumption of oil with engine running according to external characteristic at 2200 rpm duty, g/hp·h	6
Overall dimensions of engine, mm:	
length:	
with power takeoff shaft	790
w/o power takeoff shaft	748
width	1150
height	742

[redacted]

in winter	diesel fuel ДЗ or ДА (arctic, GOST 4749-49)
Fuel tanks:	
number	3
capacity, l	462
Fine fuel filter:	
number	1
type	felt, with caprone spacers
Coarse fuel filter:	
number	1
type	gauze
Fuel feed pumps:	
number	2
type	one - centrifugal; one - piston
Fuel injection pump:	
number	1
type	six-plunger, block type
Fuel injection pump governor	variable-speed, centrifugal, direct action
Injectors:	
number	6
type	closed, with slotted filter
Pressure at which injector spray tip needle is lifted, kgf/cm^2	250±3
Angle of beginning of fuel delivery, deg	24-27 before TDC in compression stroke

Engine Air Supply System

Air cleaner:	
number	1
type	cyclone, without filter elements, with automatic dust ejection

Lubrication System

Oil used	MT-16п (GOST 6360-58)
Number of tanks	1
Capacity of tank, l	48
Capacity of whole system, l	58
Oil pump:	
number	1
type	gear, two-section (delivery and suction sections)

[redacted]

[redacted]

	ter and reactive centrifuge
Oil cooler:	
number	1
type	tube-and-fin
Oil priming pump:	
number	1
type	gear, with electric motor
mark	M3H-3

Cooling System

Coolant used:	
in summer	water with three-component additive
in winter	antifreeze, grade 45 or 65 (GOST 159-52)
Filling capacity of system, l:	
water with three-component additive	52
antifreeze	48
Radiator:	
number	1
type	tube-and-fin
Pump:	
number	1
type	centrifugal
Ejector	two-manifold, multijet

Engine Preheating System

Preheater:	
number	1
type	injector, with fire-tube boiler
Optimum calorific power (at fuel consumption of 7-8 kg/h), kcal/h	40,000-50,000

Engine Starting System

Main starting system	with compressed air (from the cylinder of pneumatic equipment system)
Maximum air pressure in cylinder, kgf/cm^2	150
Minimum air pressure in cylinder, at which engine can be started, kgf/cm^2	70
Auxiliary starting system	with electric starter

Engine Water Protection Mechanism

Type	valve, with automatic and manual controls

[redacted]

Driven discs	2
Type of engine clutch control system:	
main control system	hydraulic
auxiliary control system	pneumatic

Gearbox

Type	mechanical, with constant meshing of gears
Number of speeds	five forward and one reverse
Synchronizers:	
type	inertia
installed on gears	II, III, IV and V
Gear ratio:	
1st and reverse gear	5.250
2nd gear	2.842
3rd gear	1.912
4th gear	1.284
5th gear	0.858
Low range gear ratio	1.440
Oil used	MT-8п or MT-16п (GOST 6360-58)
Amount of oil in gear case, l	20
Gearbox control:	
- on 2nd, 3rd, 4th and 5th gears	mechanical, with hydraulic servocontrol
- on 1st gear and reverse gear	mechanical

Steering Gear

Number	2
Type	planetary, double-reduction, with disc blocking clutches and brakes working in oil
Arrangement of planetary steering gear	in gear case
Number of friction discs and material:	
of blocking clutch	3 steel and 4 with cerametallic lining
of disc brake	3 steel and 4 with cerametallic lining
Steering gear control system	hydraulic
Controls:	
steering	handle bar
engagement of low range gear	gear-shift lever on handle bar
Gear ratio of planetary steering gear with blocking clutches disengaged and brakes applied	1.44

[redacted]

[redacted]

number	2
type	band, floating, double-acting
Stopping brake control system	hydraulic
Controls used:	
when turning	steering handle bar
when braking	pedal
Minimum turning radius with stopping brake applied, m	1.3
Parking brake control, type	mechanical linkage from control handle to L.H. stopping brake

Final Drive

Number	2
Type	single-reduction, planetary
Gear ratio	5.5
Oil used	MT-16п
Filling capacity, l	2
Mass of one final drive, kg	80

1.2.11. Running Gear

Propeller:	
type	caterpillar drive
arrangement of driving sprockets	front

Tracks

Type	small shoes with rubber-metal cogwheel engagement
Number of track shoes in one track	84
Method of track shoes connection	with shackles
Width of track, mm	300
Track pitch, mm	140
Mass of one track shoe, kg	6.34

Driving Sprockets

Type	with removable toothed rims
Number of rim teeth	14
Mass of driving sprocket, kg	76.3

Idler Wheels

Type	cast, w/o rubber tyres
Mass of one wheel, kg	75.3
Oil used	MT-16п
Amount of oil filled, l	0.6

[redacted]

	445-56)
Amount of lubricant filled, l	0.15

Road Wheels

Type	single-wheel, with rubber tyres
Number of road wheels (per vehicle side)	6
Mass of road wheel complete with road wheel arm, kg:	
front	71.4
middle (2nd, 3rd, 4th and 5th)	65.0
rear	69.0
Oil used	MT-16п
Amount of oil filled, l	0.47

Support Rollers

Type	single-wheel, with rubber tyres
Number (per vehicle side)	3
Mass of support roller, kg	11.75
Oil used	MT-16п
Amount of oil filled, l	0.14
Suspension	independent, torsional, with hydraulic shock absorbers

Torsion Bar

Type	solid torsion bars
Number	12

Shock Absorbers

Type	hydraulic, telescopic, double-acting
Number	4
Arrangement	in suspensions of the first and sixth road wheels
Working fluid	mixture: transformer oil (GOST 982-56) - 50% turbine oil 22п (GOST 32-53) - 50%
Amount of fluid filled in shock absorber, l	0.84

Stops

On front and rear road wheels	spring stops
On second and fifth road wheels	rubber stops

[redacted]

[redacted]

Power Sources

Storage batteries:

type	starter, lead-acid
mark	6-СТЭН-140М
number	2
total capacity, A·h	140
mass of one battery, kg	61

Generator:

type	shunted, six-pole DC generator with forced cooling
mark	ВГ-7500
power at engine crankshaft speed of 1500 rpm, kW	5
rated voltage, V	28.5
generator drive gear ratio	2.52

Power Consumers

Starter:

type	series, DC
mark	С-5
maximum power, kW	15
voltage, V	24
consumed current, A	460
starter gear-to-flywheel ratio	10.3
mass, kg	40

Electric motor of ABC protection system special blower:

mark	МВ-67
power, W	800
consumed current, A	40
number	1

Electric motors of water drainage pumps:

mark	МВП-2
power, W	300
consumed current, A	23.5
number	2

Electric motor of oil priming pump:

mark	МН-1
power, W	500
consumed current, A	40
number	1

Electric motors of loading mechanism:

mark	МУ-431
power, W	400
consumed current, A	32
number	3

[redacted]

...ated voltage, V ....ge wire, with mi
terminal grounded
.... 24

Power Sources

Storage batteries:
type ....
mark .... starter, lead-acid
number 6-СТЭН-140М
total capacity, A·h 2
mass of one battery, kg 140
Generator: 61
type ....
.... shunted, six-pole
mark .... DC generator with force
cooling
power at engine crankshaft speed of 1500 rpm, kW ВГ-7500
rated voltage, V 5
generator drive gear ratio 28.5
.... 2.52

Power Consumers

Starter:
type ....
mark .... series, DC
maximum power, kW C-5
voltage, V 15
consumed current, A 24
starter gear-to-flywheel ratio.. 460
mass, kg 10.3
Electric motor of ABC protection system special blower: 40
mark ....
power, W MB-67
consumed current, A 800
number 40
Electric motors of water drainage pumps: 1
mark ....
power, W МВП-2
consumed current, A 300
number 23.5
Electric motor of oil priming pump: 2
mark ....
power, W МН-1
consumed current, A 500
number 40
Electric motors of loading mechanism: 1
mark ....
power, W МУ-431
consumed current, A 400
number 32
.... 3

[redacted]

Electric motor of gun elevating mechanism:	
mark	ДРВ-1
power, W	65
consumed current, A	2.5
number	1
Electric motors of exhaust blowers and troop compartment heater:	
mark	Д-55
power, W	55
consumed current, A	4
number	4
Electric motor of fuel feed pump БЦН:	
mark	Д-100
power, W	150
consumed current, A	up to 5.0
number	1
Electric motor of engine preheater:	
mark	МВП-3П
power, W	150
consumed current, A	10
number	1
Converter of gyro direction indicator:	
mark	ПАГ-1Ф
voltage of converter electric motor, V	24
voltage of converter generator, V	36
current consumed by electric motor, A	3
frequency of generator three-phase current, Hz	400
Lighting devices:	
headlight with blackout device	
mark	ФГ-127
number	1
headlight on turret	
mark	ФГ-126
number	1
infrared headlight	
mark	ФГ-125
number	1
internal lighting dome light	
mark	ПМВ-61
number	7
flap lights	
mark	КМСГ-64
number	3
dome light of stand-by lighting system	
mark	ПМВ-61
number	1
Light signalling devices:	
marker lights	
mark	ГСТ-64

[redacted]

	ГСТ-64
number	1
signal lights CLOSE HATCHES (ЗАКРОЙ ЛЮКИ)	
mark	ОСЛТ-37
number	3
signal light ФПТ VALVE OPEN (ОТКР.КЛАПАН ФПТ)	
mark	ОСЛТ-37
number	1
signal light indicating readiness of loading mechanism levers to operation	
mark	ОСЛТ-37
number	1
signal lights of light panel RELEASE HAND BRAKE (ОТПУСТИ СТОЯНОЧНЫЙ ТОРМОЗ)	3
signal lights on central panel:	
GUN POSITION (ВЫХОД ЗА ГАБАРИТЫ)	2
signal of water protection mechanism valves closing VALVE (КЛАПАН)	1
signal of power plant pumping by preheater water pump ENGINE COOLING (ОХЛАЖД.ДВИГАТ.)	1
signal warning about open rear doors DOOR (ДВЕРЬ)	1
signals indicating good condition of fire-fighting equipment ППО circuits	2
signal lights on turret board:	
LOADING MECHANISM ON (red)	1
DRIVE ON (green)	1
Electric triggers:	
main gun trigger	remote, with electric primer
auxiliary gun trigger	electric, by means of duplicate electric primer and lever mechanism
machine gun trigger	remote, with electromagnet
Check and measuring instruments:	
voltammeter	
type	permanent-magnet
mark	ВА-440
thermometer	
type	remote
mark	2ТУЭ-111
engine pressure gauge	
type	remote, electrical
mark	ТЭМ-15
tachometer	ТЭ-4
speedometer	СП-106
engine hourmeter	
type	clock mechanism with electromagnetic relay

	remote, electrical
mark	ЭДМУ-6-Н
pressure gauge of pneumatic equipment system	МТ-1С

1.2.13. Communication Facilities

Radio Station

Type	transmitter-receiver, telephone, ultrashort-wave
Mark	Р-123М
Range of operation with 4-m long antenna, km:	
with noise suppressor switched off	20
with noise suppressor switched on	13
Consumed power, W	
during transmitting	250
during stand by reception	80

Interphone System

Type	telephone, with electromagnetic throat microphones
Mark	Р-124
Number of parties	5

1.2.14. ABC Protection System

Protection of crew and troopers from shock wave	sealing of driving, fighting and troop compartments
Protection from radioactive dust, chemical and bacteriological agents	air cleaning and creation of excess pressure (equal to at least 30 mm H_2O)
Method of engagement of protection mechanisms	by manual switches
Special blower	centrifugal, with inertia separation of dust
Absorbent filter	ФПТ-200М

1.2.15. Heaters of Fighting, Troop and Driving Compartments

Number	2
Type	air heaters using heat of engine cooling radiators

1.2.16. Powder Gas Suction Blowers

Number	3

[redacted]

Liquid used	compound 3.5
Number of cylinders	2
Capacity of each cylinder, l	2
Fire-sensitive units:	
number	4
arrangement	in engine compartment

Portable Fire Extinguisher

Type	carbon dioxide
Mark	OУ-2
Number	1
Capacity of cylinder, l	2

1.2.18. Concealment Means

Type	smoke-generating equipment, multiple-action
Time of system continuous operation, min	5

1.2.19. Water Drainage Facilities

Pumps with electric drives:	
type	centrifugal
number	2
output, l/min	100
Pump with mechanical drive:	
type	centrifugal
number	1
output, l/min	100

1.2.20. Pneumatic Equipment

Compressor

Type	piston, two-cylinder, three-stage
Mark	AK-150MKB
Operating pressure, kgf/cm^2	150
Number	1

Cylinder

Number	1
Capacity, l	5

Air Pressure Control Unit

Type	valve
Mark	АДУ-2С
Number	1

[redacted]

	1

Pressure Reducing Valves

High-pressure reducing valve:	
mark	НД-611-150/70
number	2
pressure at outlet, kgf/cm^2	70
Low-pressure reducing valve:	
mark	669300/М-14
number	1
air pressure at outlet, kgf/cm^2	14

Oil-and-Moisture Separator

Type	centrifugal
Number	1

Electropneumatic Valves

Mark	ЭК-48
Number	3

[redacted]

[redacted]

2. VEHICLE HULL AND TURRET

2.1. PURPOSE

The vehicle hull and turret are designed to accommodate and protect the vehicle crew, assemblies, mechanisms and systems.

2.2. ARMOUR HULL

2.2.1. General

The hull (Fig.12) is welded of rolled steel armour plates.

The hull front section consists of lower front sloping plate 5 and upper front sloping plate 6. Welded to the lower front sloping plate from the outside are two towing hooks and two eyes for attachment of the vehicle in aircraft. For access to the engine compartment the upper sloping plate 6 has a large hatch closed with hinged ribbed plate 2. Welded to the upper plate are six hinges for attachment of splash panel 1 and the headlight mounting brackets and headlight guards 54.

The hull side plates consist of upper, middle and lower side plates. The upper side plates are moved apart forming bays for installation of the ball supports of machine guns ПК and submachine guns AKM and other assemblies. Welded to the rear part of lower side plate are inserts 35 for fastening of idler wheel cranks 29 and in the front part, inserts 52 for fastening of the final drives. Welded from the outside are brackets 51 for attachment of shock absorber lever supports, fender attaching hinges 24 and other fastening parts.

Cut in rear plate 26 are two large hatches, closed by door-tanks 27. The doors are installed on hinges 32.

The vehicle bottom (Fig.13) has longitudinal stampings 14 and lateral hollow beams for rigidity. The torsion bars are arranged inside the hollow beams. For servicing of the vehicle assemblies, the bottom has a hatch closed with cover 8 and holes closed with plugs. Rubber gaskets are placed under the covers and plugs.

The hull roof (Fig.14) has front removable plate 31 for access to the power plant assemblies and the nonremovable plates. The roof is made rigid by lateral and longitudinal hollow beams and four struts 27 (Fig.5). Provided in the roof are hatches, ports and holes for access to the assemblies and systems during operation, servicing and repair of vehicle. Secured to the inner side of the roof and the troop compartment sides is the padding.

The engine compartment bulkhead insulates the driving and fighting compartments from the power assemblies. The bulkhead is made of aluminium alloy plates with foam plastic place in-between for better sealing and sound absorption. For access to the power plant assemblies the bulkhead has hatches, arranged as shown in Fig.15. Besides, secured to the bulkhead are handles 5, 11, 12 and 13, and cock 14 with handle.

For passage of the control rods and shafts the bulkhead has holes 16, 18 and 19, sealed with rubber corrugated pipes and gaskets. Built into the bulkhead from the fighting compartment side is the air duct pocket, connected with the air cleaner. The pocket has access

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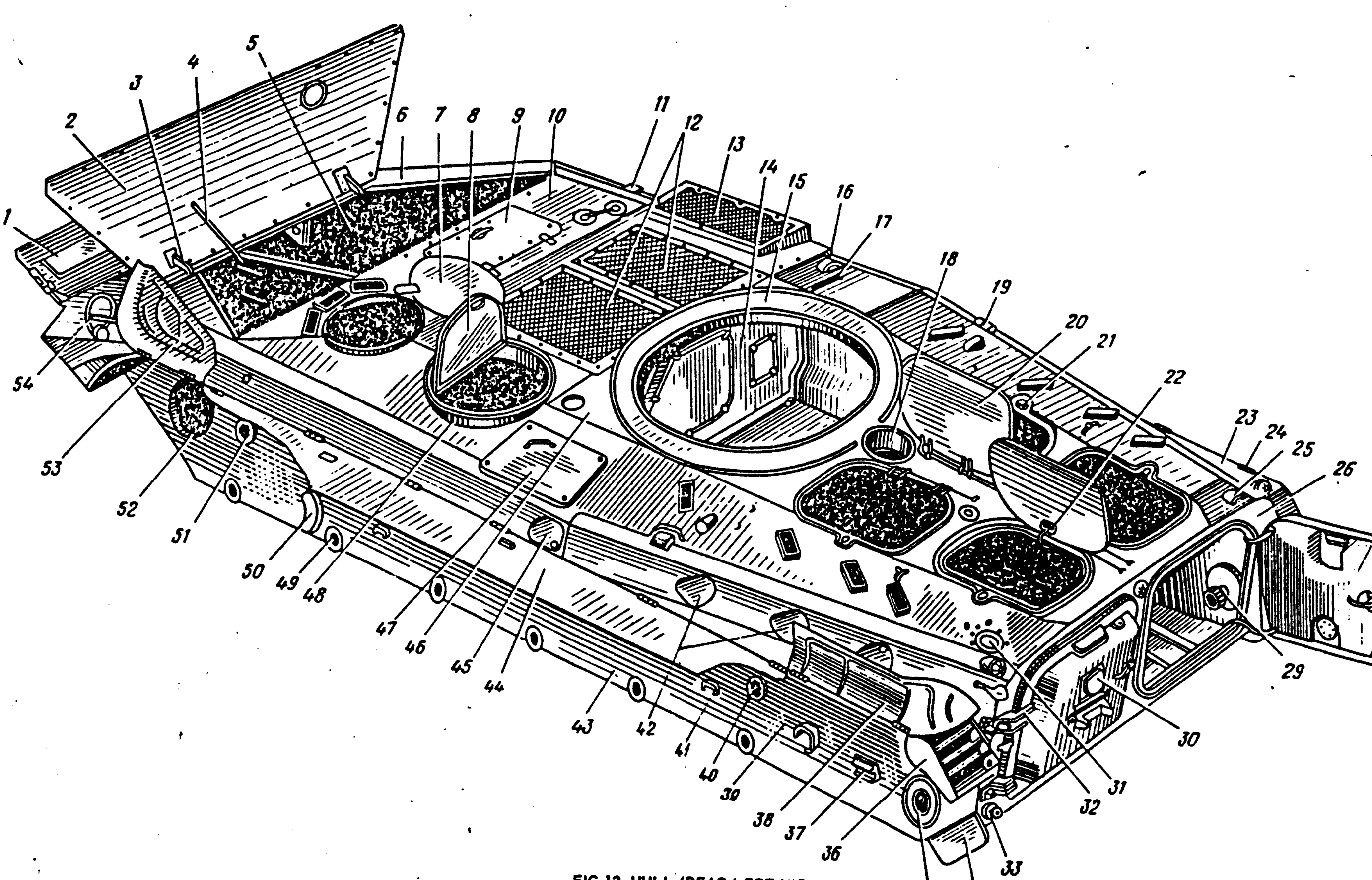

FIG.12. HULL (REAR LEFT VIEW)

1 - splash panel; 2 - ribbed plate; 3 - left-hand fastening (bracket) of ribbed plate; 4 - ribbed plate hold-open lock; 5 - lower front plate; 6 - upper front plate; 7 - driver's hatch door; 8 - commander's hatch door; 9 - engine access hatch cover; 10 - removable plate of engine compartment roof; 11 - cover of hole for ejection of water from front water drainage pump; 12 - nets above louvres; 13 - net above ejector shutters; 14 - engine compartment bulkhead; 15 - annular air duct; 16 - cover of hole for ejection of water from middle water drainage pump; 17 - handle of port cover for release of exhaust gases from preheater boiler; 18 - hole for passage of air intake pipe; 19 - exhaust blower port cover; 20 - troop hatch door; 21 - troop hatch door lock; 22 - sector of troop hatch door; 23 - fender shelf; 24 - fender rear plate attaching hinge; 25 - cover of hole for ejection
of water from rear water drainage pump; 26 - rear plate; 27 - door-tank; 28 - door lock; 29 - id
wheel crank; 30 - cover of rear firing port for submachine gun; 31 - hole for fastening of ante
lead-in; 32 - door hinges; 33 - eye ring for fastening of vehicle in aircraft; 34 - track pin dri
tam; 35 - insert for fastening of idler wheel crank; 36 - guide vanes; 37 - fastening of cleane
fender rear plate; 39 - vehicle side middle plate; 40 - road wheel attaching flange; 41 - stop
bracket; 42 - armour covers of firing ports for submachine guns; 43 - lower side plate; 44 - f
middle plate; 45 - armour cover of firing port for machine gun; 46 - hull roof; 47 - filter ФПТ
cess hatch cover; 48 - commander's hatch; 49 - road wheel arm front support; 50 - road wheel
bend limiter; 51 - hydraulic shock absorber link attaching bracket; 52 - insert for final drive
fastening; 53 - fender front plate; 54 - headlight guard

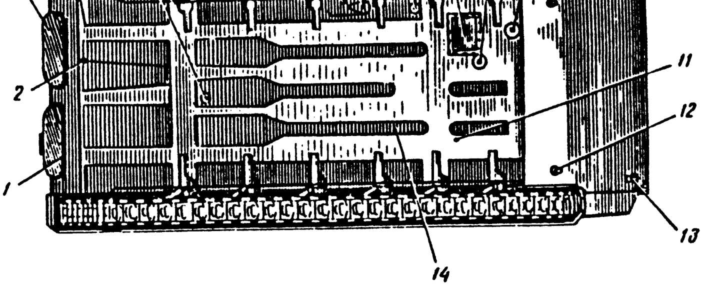

FIG.13. VEHICLE BOTTOM

1, 3 - door-tanks; 2 - vehicle water drain plug; 4 - fuel tank drain plug; 5 - ejector water drain valve; 6 - cover of hole for release of preheater boiler exhaust gases; 7 - oil tank drain plug; 8 - cover of hatch under engine; 9 - plug for draining oil from engine crankcase; 10 - plug for draining oil from gearbox and coolant from gear case pan; 11 - valve for draining of coolant from engine cooling system; 12 - eye-bolt for attachment of vehicle in aircraft; 13 - towing hook; 14 - longitudinal stampings

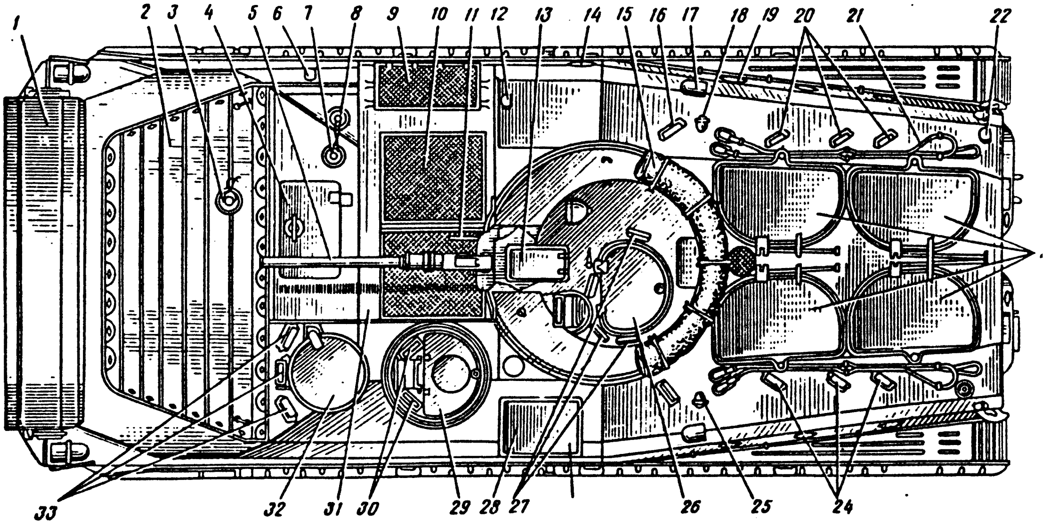

FIG.14. HULL ROOF

1 - splash panel; 2 - ribbed plate; 3 - plug of hole for filling oil in gearbox; 4 - cover of hatch above engine; 5 - gun barrel; 6 - cover of hole for ejection of water pumped by front water drainage pump; 7 - plug of hole for filling of coolant into the engine cooling system; 8 - plug of hole for filling oil into engine oil tank; 9 - net above ejector shutters; 10 - net above louvres; 11 - machine gun; 12 - cover above hole for ejection of water pumped by middle water drainage pump; 13 - cover of ATGM feed hatch; 14 - machine gun firing port; 15 - canvas cover; 16 - machine gunner's vision device; 17 - exhaust blower hole cover; 18, 25 - side marker lights; 19 - submachine gun firing port; 20, 24 - submachine gunners' vision devices; 21 - towing wire rope; 22 - cover of hole for ejection of water pumped by rear water drainage pump; 23 - troop hatches; 26 - operator's hatch door; 27 - operator's vision devices; 28 - cover of access hatch to absorbent filter ФПТ-200М; 29 - commander's hatch door; 30 - commander's vision devices; 31 - hull roof removable plate; 32 - driver's hatch door; 33 - driver's vision devices

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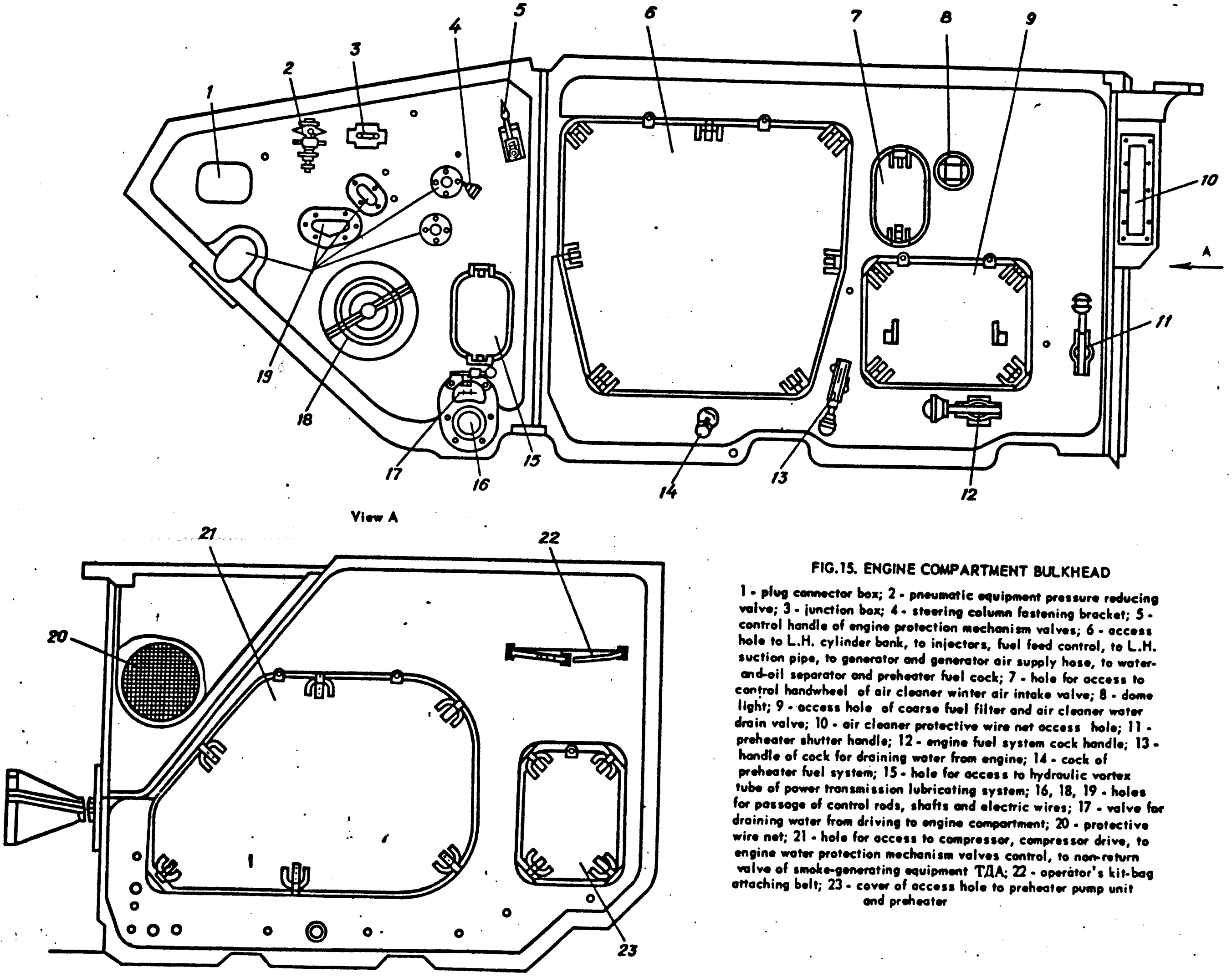

FIG.15. ENGINE COMPARTMENT BULKHEAD

1 - plug connector box; 2 - pneumatic equipment pressure reducing valve; 3 - junction box; 4 - steering column fastening bracket; 5 - control handle of engine protection mechanism valves; 6 - access hole to L.H. cylinder bank, to injectors, fuel feed control, to L.H. suction pipe, to generator and generator air supply hose, to water-and-oil separator and preheater fuel cock; 7 - hole for access to control handwheel of air cleaner winter air intake valve; 8 - dome light; 9 - access hole of coarse fuel filter and air cleaner water drain valve; 10 - air cleaner protective wire net access hole; 11 - preheater shutter handle; 12 - engine fuel system cock handle; 13 - handle of cock for draining water from engine; 14 - cock of preheater fuel system; 15 - hole for access to hydraulic vortex tube of power transmission lubricating system; 16, 18, 19 - holes for passage of control rods, shafts and electric wires; 17 - valve for draining water from driving to engine compartment; 20 - protective wire net; 21 - hole for access to compressor, compressor drive, to engine water protection mechanism valves control, to non-return valve of smoke-generating equipment ТДА; 22 - operator's kit-bag attaching belt; 23 - cover of access hole to preheater pump unit and preheater

[redacted]

hole 10, intended for access to protective wi[redacted] 20 of the air cleaner branch pipe and closed with a cover. Secured to the bulkhead from the driving compartment side is pneumatic equipment pressure reducing valve 2, plug connector box 1 and valve 17 for draining water from the driving to engine compartment.

2.2.2. Hull Hatches and Doors

The driver's hatch (Fig.16) is located in the roof front part on the left. Round hatch door 7 is welded to bracket 9, secured on shaft 10. The hatch door is opened and closed by means of an eccentric lock. The lock consists of sleeve 11, installed in the vehicle roof, shaft 10, pin 14, handle 18, fork 19 with eccentric cylindrical cheeks, spring 20, a rod and a stop.

Pin 14 enters into the holes of fork 19 and shaft 10, joining them, and is locked with lockpin 16.

As handle 18 is turned in horizontal plane, fork 19 and connected to it pin 14, shaft 10 and hatch door 7 are also turned. When the handle is displaced in vertical direction, fork 19 turns and thrusts against bevelled surfaces of sleeve 11 with its eccentrics 13, thus lifting or lowering shaft 10 together with hatch door 7.

Mounted in bracket 9 is a retainer for locking the hatch door in open position.

Turning of the hatch door beyond the extreme positions is prevented by handle travel limiter 17.

Built in the handle is spring-loaded retainer, intended for locking the handle in the extreme positions.

In the closed position hatch door 7 is locked with a locking device consisting of a handle, turning relative to fixed bracket 2, and rod 22, which enters into the slot of shackle 6 (welded to the hatch door) when the door is closed.

Lifting and lowering of the hatch door is possible from inside the vehicle only. Made on the end of bracket 9 is a limiter which thrusts in the extreme positions (in horizontal plane) against a stop welded to the roof.

For tight closing of the hatch door glued into the groove of hatch door seat 3 is sealing ring 4. Sleeve 11 has a port accommodating the pin of the limit switch of hatch-open signalling system; when the hatch door is closed, a lug on shaft 10 presses the limit switch pin, thus opening the circuit of pilot lamp CLOSE HATCHES (ЗАКРОЙ ЛЮКИ).

The commander's hatch (Fig.17) is located behind the driver's hatch. Hatch door 5 rests on a ball support, ensuring all-round rotation of the vision devices and the spotlight.

Rotation of the hatch door rigidly connected with upper race 20 is limited by two stops.

Secured to lower race 19 is a lock, intended to retain the upper race in two positions: 1st position - the commander's vision device is directed forward; 2nd position - the device is turned 90° to the left and the commander observes through prismatic device ТНПО-170.

The lock consists of housing 35, rod 32, spring 33 and handle 34. While locking, rod 32 end fits into one of the two holes provided in the lower race.

For easier opening of the hatch door, its fastening unit incorporates a torsion bar passing through the hollow shafts welded to the hatch door.

The hatch door is closed by wedge lock 7. The main parts of the lock are sleeve 26 accommodating an axle having threading on one end and a cut-out for the key on the other end, handle 24 with a wedge end-piece and spring-loaded retainer 30. Sleeve 26 is installed in hatch door 5. Fitted on the axle and secured by nut 27 is handle 24. Spring 29 inserted into the handle seat, presses cylindrical retainer 30 to the sleeve lower surface, having two grooves. As handle 24 is turned, its wedge-shaped end engages (or gets clear off) the upper race edge, clamping (or releasing) the hatch door. For opening of the lock from outside the sleeve has a hole and a recess for the key is made in the axle.

When opened, the hatch door is held by the lock. The lock consists of the housing, handle rod and retainer. The lock handle is secured from the inner side of the vehicle roof on a rod,

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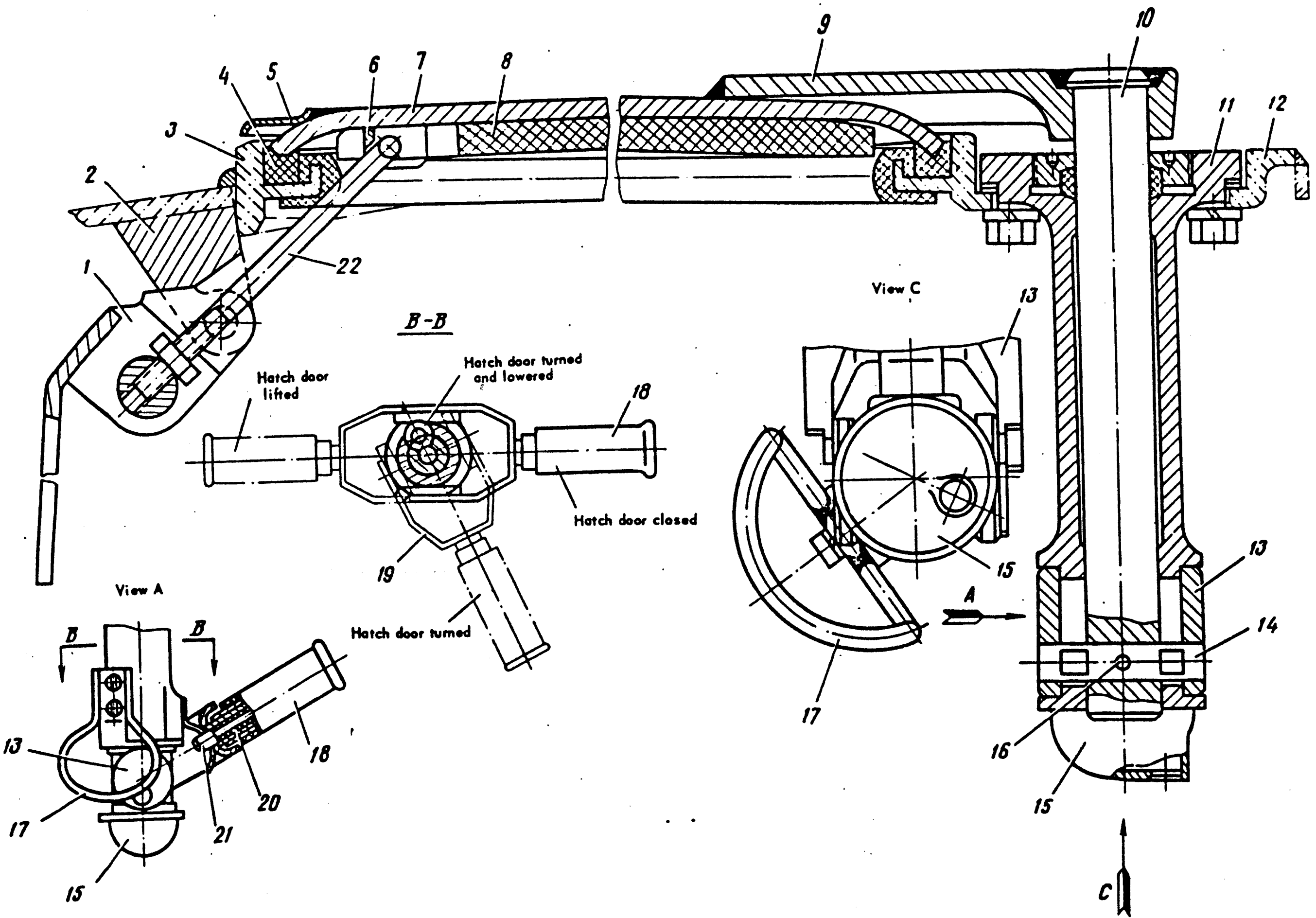
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3
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22
1
B-B
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13
Hatch door turned and lowered
Hatch door lifted
18
Hatch door closed
19
15
13
A
14
View A
B
B
Hatch door turned
17
16
13
18
17
20
21
15
15
C

FIG.16. DRIVER'S HATCH

1 - locking device handle; 2 - bracket; 3 - hatch door seat; 4 - sealing ring; 5 - protective visor; 6 - shackle; 7 - hatch door; 8 - padding; 9 - hatch door fastening bracket; 10 - shaft of bracket; 11 - sleeve; 12 - vehicle roof; 13 - handle eccentric; 14 - handle pin; 15 - cap; 16 - lockpin; 17 - handle travel limiter; 18 - handle; 19 - handle fork; 20 - retainer spring; 21 - retainer; 22 - lock rod

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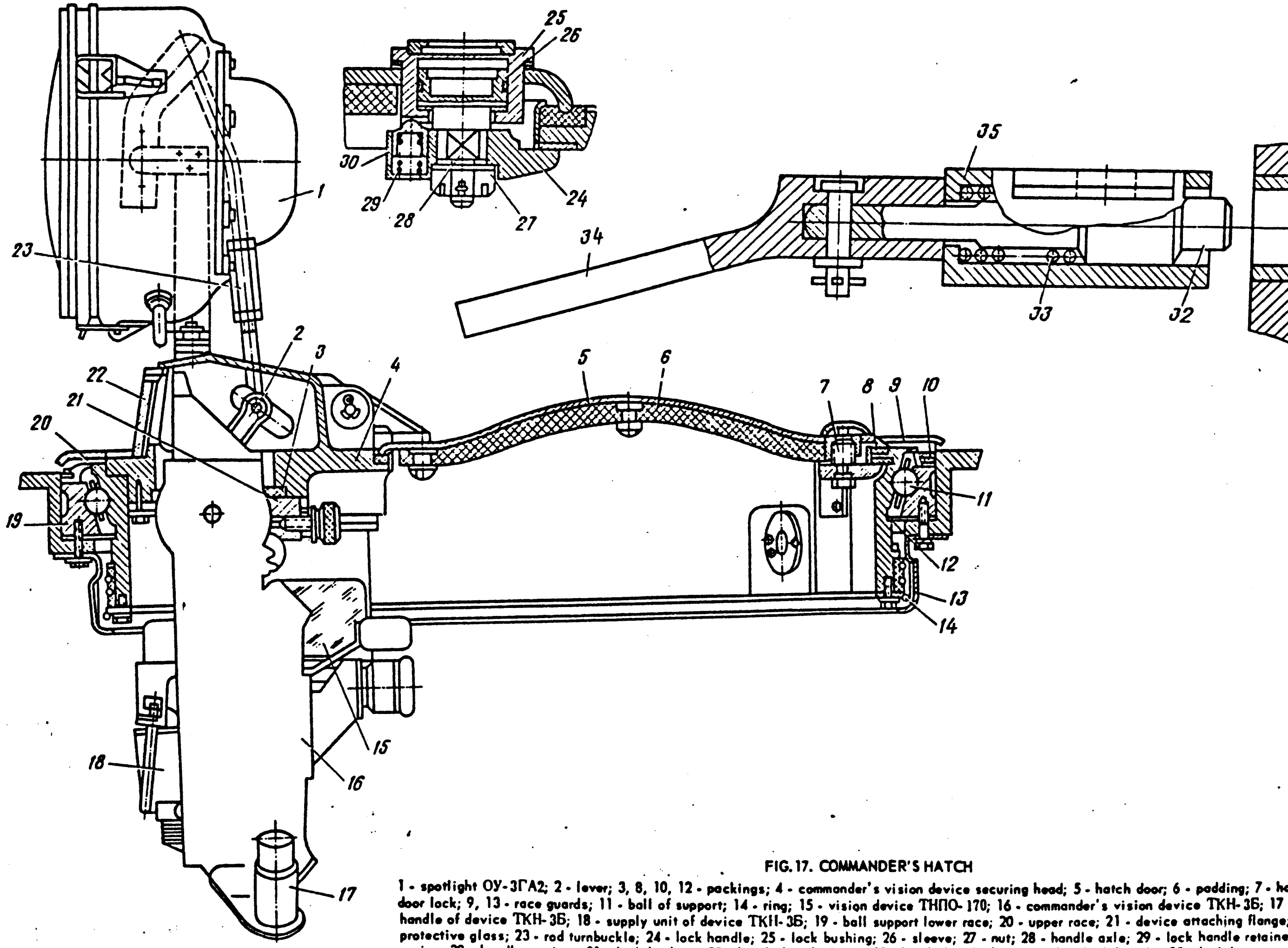
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34
35

FIG. 17. COMMANDER'S HATCH

1 - spotlight ОУ-3ГА2; 2 - lever; 3, 8, 10, 12 - packings; 4 - commander's vision device securing head; 5 - hatch door; 6 - padding; 7 - h
door lock; 9, 13 - race guards; 11 - ball of support; 14 - ring; 15 - vision device ТНПО-170; 16 - commander's vision device ТКН-3Б; 17
handle of device ТКН-3Б; 18 - supply unit of device ТКН-3Б; 19 - ball support lower race; 20 - upper race; 21 - device attaching flange
protective glass; 23 - rod turnbuckle; 24 - lock handle; 25 - lock bushing; 26 - sleeve; 27 - nut; 28 - handle axle; 29 - lock handle retaine
spring; 30 - handle retainer; 31 - lock bushing; 32 - hatch door lock rod; 33 - hatch door lock spring; 34 - lock handle; 35 - lock housing

go. To release the hatch door, push the hatch door forward and then pull it back.

2.2.3. Troop Compartment Hatches

Provided in the troop compartment roof are four identical hatches, closed with hatch doors 20 (Fig.12). Hatch door 1 (Fig.18) is attached on two hinges 3 and 5 in which torsion bars 4 are installed.

One end of the torsion bar is secured in hinge 5 welded to the hatch door, and the other in eye 2 welded to the hull roof. When the hatch door is closed the torsion bar is twisted; when the door is opened the torsion bar untwists, facilitating lifting of the hatch door.

The wedge-type locks (Fig.19) are installed for fastening of the hatch doors.

Lock 2 is essentially a cylinder with a lug (catch) made at its upper end and with bracket 8 secured from below with the help of pin 9. In its turn bracket 8 is connected by means of shaft 11 with lock handle 12. Fitted on shaft 11 is spring 10 holding handle 12 in the upper position. Provided on the end face of handle 12 is tooth "a" which enters into the recess of bushing 3 and holds the handle from turning.

To open hatch door 4, pull down handle 12 so that the handle tooth gets out of engagement with the bushing and turn the handle counterclockwise. A stop is provided on bushing 3 for limiting of the handle travel.

In the open position the hatch doors are fixed by spring-loaded retainers 7 (Fig.18) secured on the vehicle roof. When the hatch door is lifted, the retainer actuated by the spring enters into the hole of sector 9, welded to the hatch door, thus locking it.

The sealing rubber gaskets are secured along the hatch perimeter.

To close the hatch door, one must pull the retainer handle, lower the hatch door and, turning lock handle 12 (Fig.19) clockwise, lock the hatch door. Do not leave the hatch door unlocked.

The engine access hatch has hinged cover 9 (Fig.12) which is secured by means of eight bolts.

Two rear hatches of the troop compartment are closed with armour doors 45 (Fig.3), which are simultaneously the rear fuel tanks. Welded for this purpose to the door armour plates from the inside are stamped shaped plates (Fig.21), which make the tank cavities together with the door armour plates. Each door rotates on two hinges 14 welded to the hull rear armour plate. For tight closing of the doors glued along the hatch perimeter is foamed rubber gasket 9, pressed into which is the rib welded along the perimeter of the doors.

The doors are closed with locks (Fig.22). The locks of both doors are similar in design. Each lock consists of insert 18 welded into the armour plate of door 17, axle 25 the ends of which protrude from both sides of the door, spring 26, overrunning clutch 12, latch 5 and handles: outer handle 19 and inner handle 3. Handle 19 is fitted over the splines of axle 25 and is held from axial displacement by nut 21. Fitted on the axle other end is inner handle 3. Overrunning clutch 12 allows independent operation of the handles. The clutch consists of two concentric bushings and four balls 13 placed between the bushings. The profile of the groove for the balls permits independent turning of the bushings in one direction and their combined turning in the other direction. The inner race of the clutch is fitted on the tetrahedral end of axle 25, whereas the outer one is pressed into the seat of handle 3 and is secured with three lockpins. Bracket 27, welded to the door, accommodates latch 5. Lever 14 fitted on the axle tetrahedral end enters the latch slot. The latch tooth under the action of spring 28 engages with the plate of clamp 15 locking the door. When one of the handles is turned, axle 25 and lever 14 also turn; the lever arm shifts latch 5, compressing spring 28

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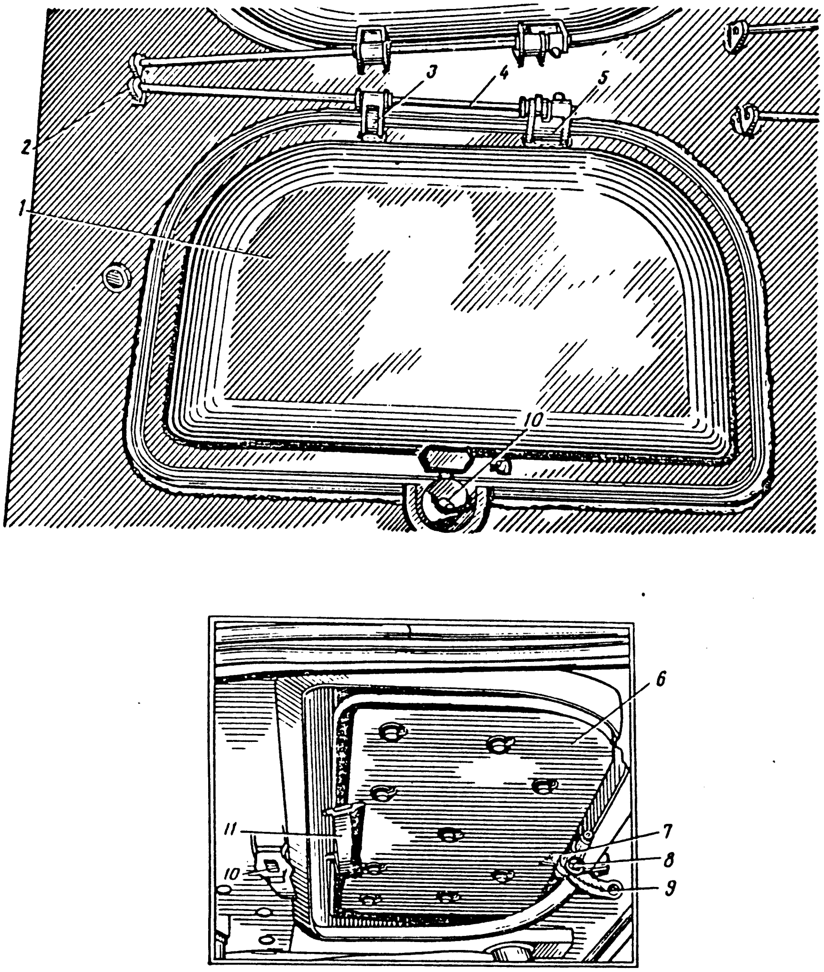
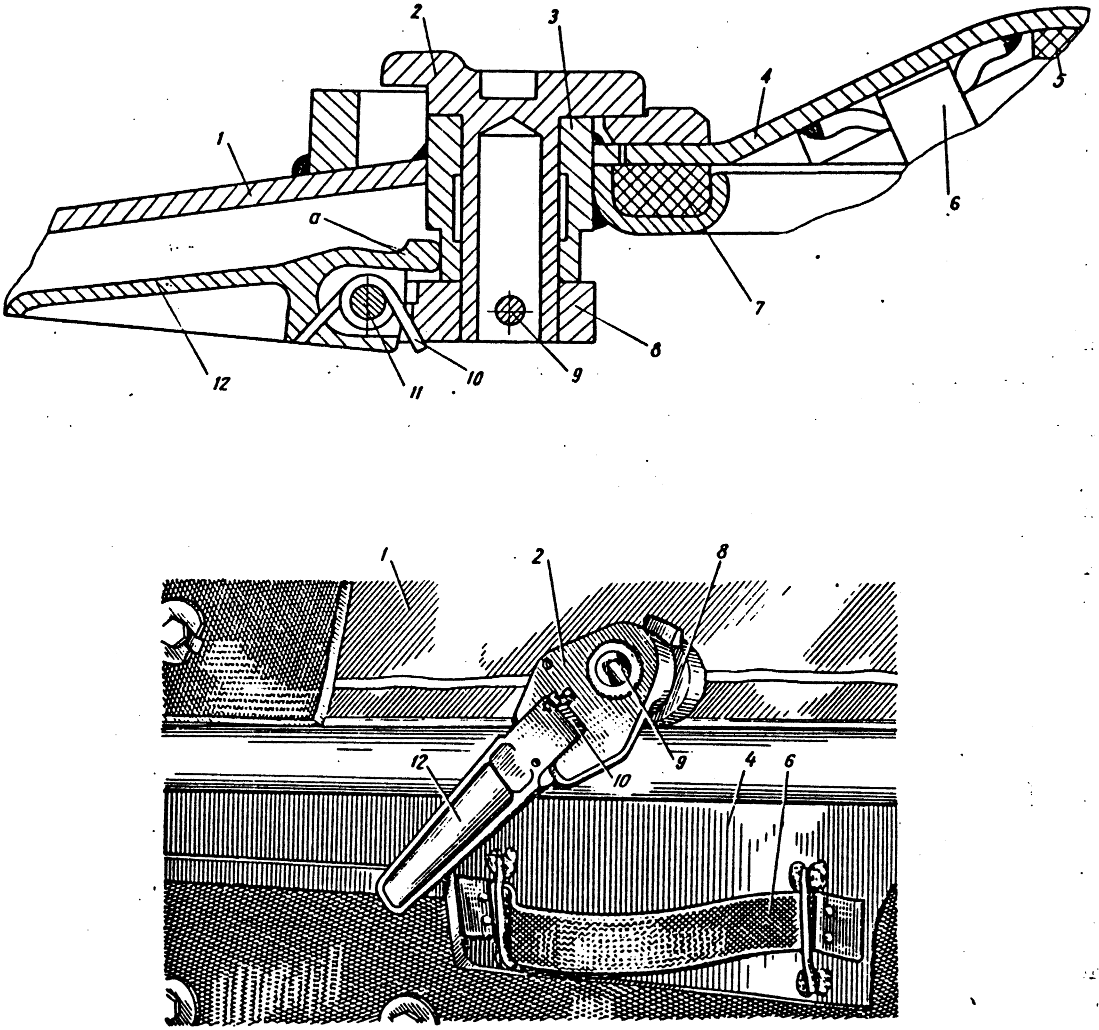


FIG. 18. TROOP COMPARTMENT HATCH

1 - hatch door; 2 - eye; 3 - hinge; 4 - torsion bar; 5 - hinge; 6 - padding; 7 - retainer; 8 - retainer handle; 9 - hatch door sector with hole for retainer; 10 - lock; 11 - handle

[redacted]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6

FIG. 19. TROOP COMPARTMENT HATCH DOOR LOCK

1 - hull roof; 2 - lock; 3 - lock bushing; 4 - hatch door; 5 - padding; 6 - door handle; 7 - door handle packing; 8 - bracket; 9 - pin; 10 - spring; 11 - shaft; 12 - lock handle; a - handle tooth

[redacted]

and withdraws its tooth from clamp 15 opening the door. When axle 25 is turned, spring 26 is twisted, and returns the handle and the latch to the the initial position afterward.

Inner handle 3 mounts retainer 9 locking it in the closed position. To disengage the handle from the retainer, depress button 7; the button compresses spring 8 and withdraws the head of retainer 9 from the recess releasing the handle. Fitted inside handle 19 is lock 23 closed with washer 22. The lock serves to close the doors from the outside. A hole provided in the washer and the lock is intended for a special key which serves to open the door from the outside.

For tight closing of the doors which is especially required before crossing water obstacles, installed on the inner side of the left-hand door is the door locking mechanism.

The mechanism consists of handwheel 29 connected by means of three gears 32, 36 and 38 with screw 37; screwed on the latter is clamp 15. Clamp 15 is arranged in the same plane with the tooth of latch 5 and with the doors closed the latch is pressed to the clamp. For tight dogging up of the doors, rotate the handwheel in clockwise direction. In this case clamp 15 will displace along screw 37 thrusting against latch 5 and will pull the doors to the vehicle hull.

To open the dogged-up doors, rotate handwheel 29 counterclockwise until stop, depress button 7 and turn handle 3 down.

The doors are kept in open position by spring-loaded retainers 13 (Fig.21).

The spring-loaded retainer incorporates a lever mounted on an axle secured in brackets welded from the outside to the rear armour plate. Fitted on the lever axle is a spiral spring, pressing the lever arm with the locking tooth back. As the doors are opened the plate on the door outer surface presses off the lever and gets engaged with the retainer tooth.

To open the retainer from inside the vehicle, use the button with the rod passing through the door and pressing against the other end of the lever. A return spring is fitted on the rod. To release the door from the retainer 13 from the outside of the vehicle, depress the second arm of the retainer directly, and from the inside, use the button. To facilitate disengagement of the retainer, prior to pressing the arm or button, press the door towards opening to set free the retainer.

Cut in the doors are the ports for mounting of vision devices ТНПО-170 protected with casings. The right-hand door has a port for small arms firing, closed with an armour cover. Secured from the outside of the doors are the spare track shoes, and from the inner side - the bags of the headsets. Welded from the outside in the upper part of the doors are the pipe unions for filling fuel into the tanks; they are closed with plugs. In the bottom part there are unions for connection of flexible hoses for supply of fuel to the power plant fuel feed system. The tanks communicate with the atmosphere through the drain pipes welded inside the tanks.

2.2.4. Preheater Outlet Hole

The outlet hole (Fig.20) serves to let out the preheater exhaust gases. It is located in the troop compartment front part in the hull bottom near the vehicle right side. The outlet hole has cover 6 (Fig.13) which can be opened from inside the vehicle by means of the locking device. The device consists of axle 16 (Fig.20) welded to cover 17, handle 8 secured on the end of the axle by means of lockpin 3 and spring-loaded retainer 13.

Axle 16 is installed in bushing 14 welded to the vehicle bottom and secured by nut 2. The sealing of the outlet hole is provided by packing installed in the cover and consisting of a gasket and shaped washer 19 with rubber sealing ring 20 covered with asbestos fabric compressed between them.

The packing is secured in the cover by means of bolt 18 and washer 19.

To limit turning of the outlet hole cover, welded to the latter is the tubular stop screwed into the end of which is bolt 5. Locking of the cover in the open position is provided by retainer 13 entering a recess on axle 16.

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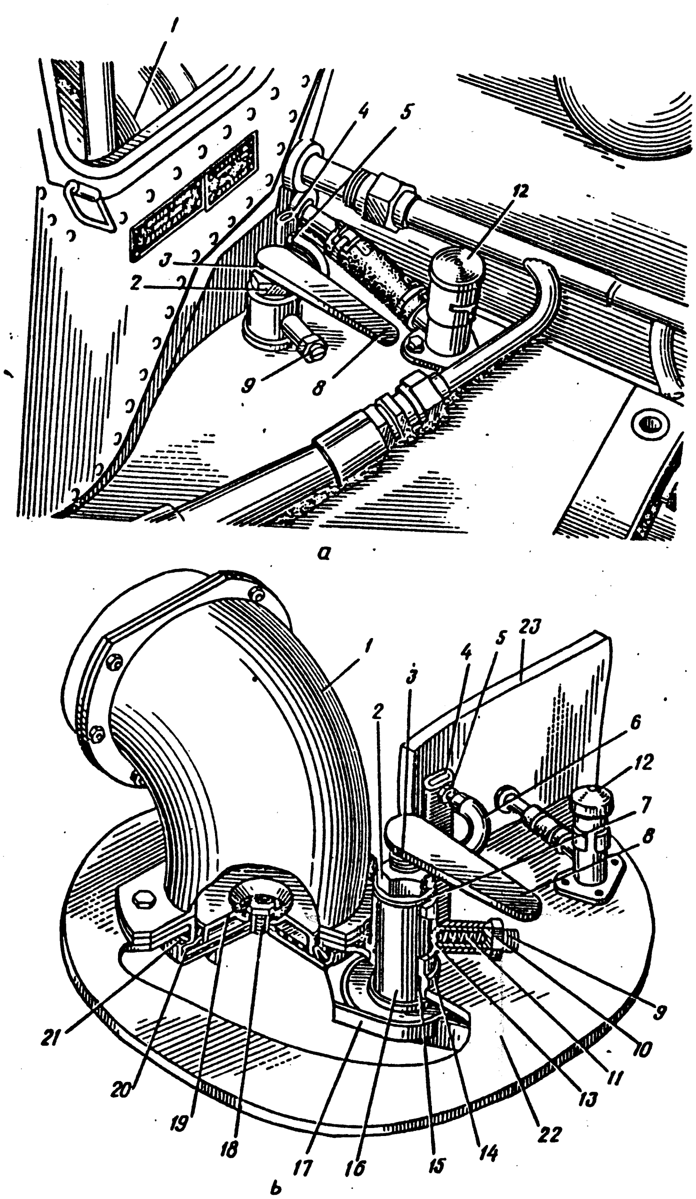
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FIG.20. PREHEATER OUTLET HOLE

a - general view; b - design

1 - preheater outlet pipe; 2 - axle attaching nut; 3 - lockpin; 4 - post; 5 - handle turn limiter bolt; 6 - handle stop; 7 - washer; 8 - handle; 9 - retainer screw; 10 - locknut; 11 - retainer spring; 12 - ejector water drain valve; 13 - retainer; 14 - bushing; 15 - bushing packing; 16 - handle axle; 17 - hole cover; 18 - outlet hole packing attaching bolt; 19 - shaped washer; 20 - sealing ring; 21 - supporting ring; 22 - vehicle bottom; 23 - engine compartment bulkhead

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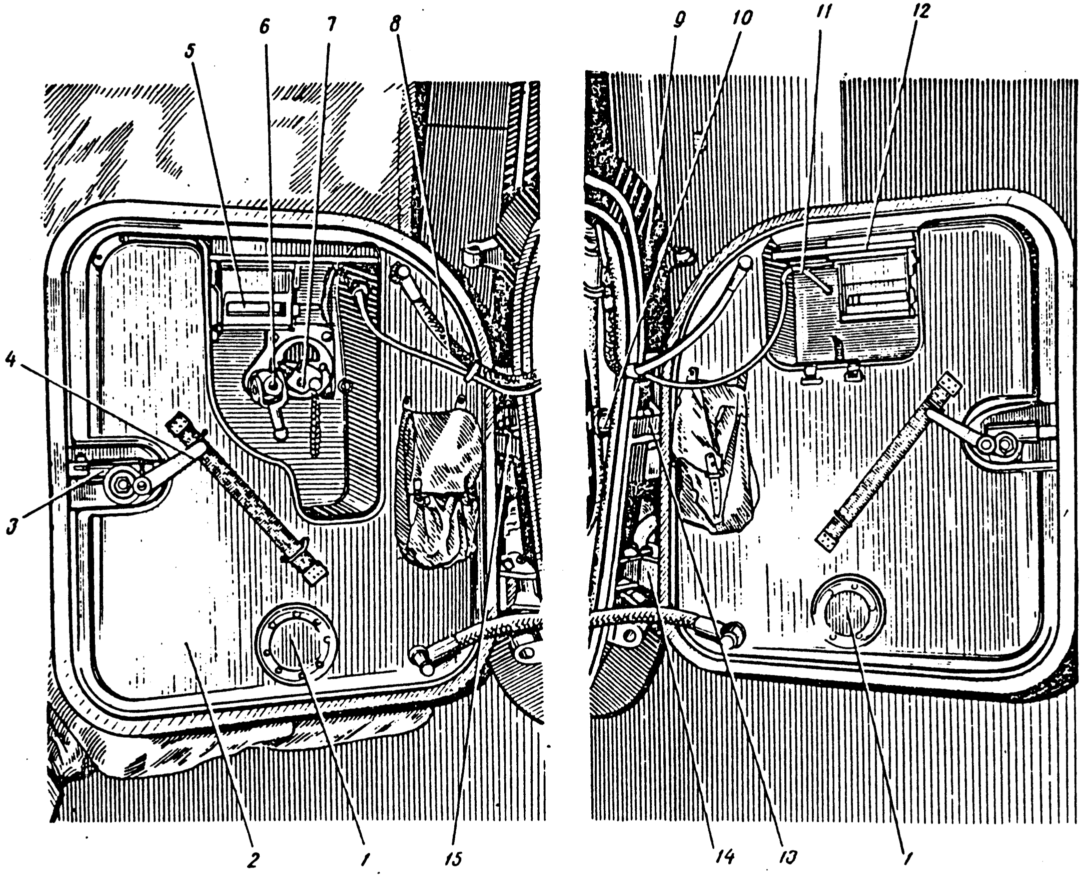

FIG.21. REAR DOORS

1 - access hole for washing of tank; 2 - fuel tank; 3 - lock; 4 - lock handle; 5 - vision device 'ТНПО-170; 6 - handle of firing port armour cover; 7 - submachine gun ball support; 8 - fuel line; 9 - door gasket; 10 - handle of door hold-open retainer; 11 - supply wire of vision device electric heating; 12 - pipe; 13 - door hold-open retainer; 14 - door hinge; 15 - retainer axle

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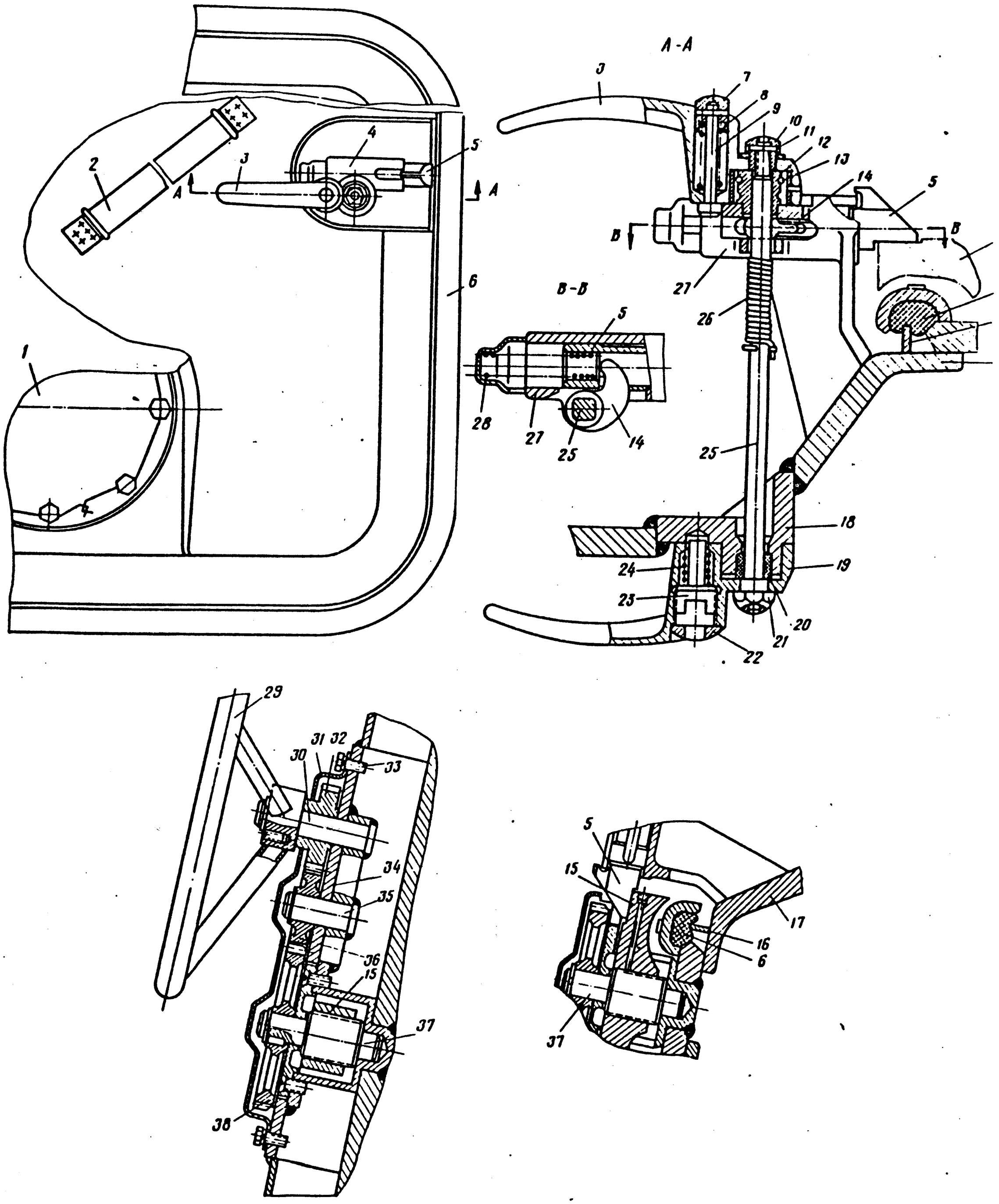
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FIG.22. LOCK AND REAR-DOOR LOCKING MECHANISM

1 - cover of hole for fuel tank cleaning; 2 - handle; 3 - inner handle; 4 - lock; 5 - latch; 6 - door packing gasket; 7 - retainer button; 8 - retainer spring; 9 - retainer; 10 - nut; 11 - lockpin; 12 - overrunning clutch; 13 - ball; 14 - lever; 15 - clamp; 16 - rib, 17 - door; 18 - insert; 19 - outer handle; 20 - rubber rings; 21 - axle nut; 22 - washer with hole; 23 - handle lock; 24 - lock spring; 25 - handle axle, 26 - axle spring; 27 - bracket; 28 - latch spring; 29 - door locking handwheel; 30 - axle of handwheel and drive gear; 31 - mechanism cover; 32 - drive gear; 33 - cover attaching bolt; 34 - housing of door locking mechanism; 35 - intermediate gear axle; 36 - intermediate gear; 37 - clamp screw; 38 - driven gear

[redacted]

Welded along the hull sides above the tracks are the shelves, secured to which by bolts and hinges are three removable fenders (on each side of the vehicle), protecting th vehicle from dirt, snow and dust. Welded in the rear part of the fenders are guide vanes (Fig.12) consisting of the housing and four transverse vanes. L-shaped straps are welded the vehicle sides for correct location of the guide vanes. The fenders together with the shelves and guide vanes form the tunnels where the upper runs of the tracks move; this arrangement serves to direct the stream of water when the vehicle is afloat and to improve the vehicle watergoing ability.

Fastening of the guide vanes (Fig.23) allows its dismounting and mounting.

Mounting of the guide vanes is performed as follows:

- sector 6 of the guide vanes is inserted into guide strips 2 and 5 and is shifted u the two holes of the sector are aligned with the two holes in bracket 3;
- secure the guide vanes with two bolts 4 and cotter the bolts;
- secure the guide vanes to the fender with bolts 1.

If the holes for bolts are not aligned, match them.

2.2.6. Splash Panel and Its Control

The splash panel (Fig.24) protects the vehicle front part from flooding. It is a ste aluminium plate, stiffened with angles 23 and cover plates 21.

The splash panel is secured on two hinges 18 on upper sloping plate 13 of the vehic hull.

The splash panel may be in two extreme positions - brought up for movement in water and brough down to rest on the hull upper sloping plate (when moving on land).

The twin pneumomechanical control of the splash panel consists of two similar syste located on the panel right and left sides.

Each of the systems includes levers 15 and 17 which are hinge-jointed with the panel by means of pins 16, rack 8, toothed sector 10 fitted over the splines of axle 12 and pneumatic cylinder 1 with rod 7.

The splash panel is controlled by handle 14 (Fig.6) of the splash panel pneumatic system cock.

To bring up the panel pull handle 14 and set it in position LIFTED (ПОДН.). Then the air from the system is delivered into spaces "A" (Fig.24) of the pneumatic cylinders an pistons 2 move back displacing rods 7 and racks 8. The rack teeth make sector 10 and lev 15 turn; the lever through rod 7 turns the splash panel and brings it in the position fo amphibious operation.

Stops 14 are welded to the hull side to limit travel of levers 15. The stop is arra so that in the lower position of lever 15 it thrusts against lever 17, thus preventing folding of the splash panel under water pressure. Secured on axles 12 are levers 3; fitt in the eyes of the levers are the ends of springs 5; the other ends of the springs are secured in angles 4. Springs 5 serve to lock the position of the levers.

To bring down the splash panel cock handle 14 (Fig.6) must be lifted and set in position LOWERED (ОПУЩ). In this case air is delivered to space "B" (Fig.24) under the pisto and under its pressure the splash panel returns to the initial position.

2.2.7. Driver's Protective Hood

The semi-open driver's protective hood (Fig.25) is used for driving the vehicle in travelling position. It consists of base 13, three shields 2, 5 and 11 and canvas canop Installed in the front and side shields are two-ply electrically-heated glasses.

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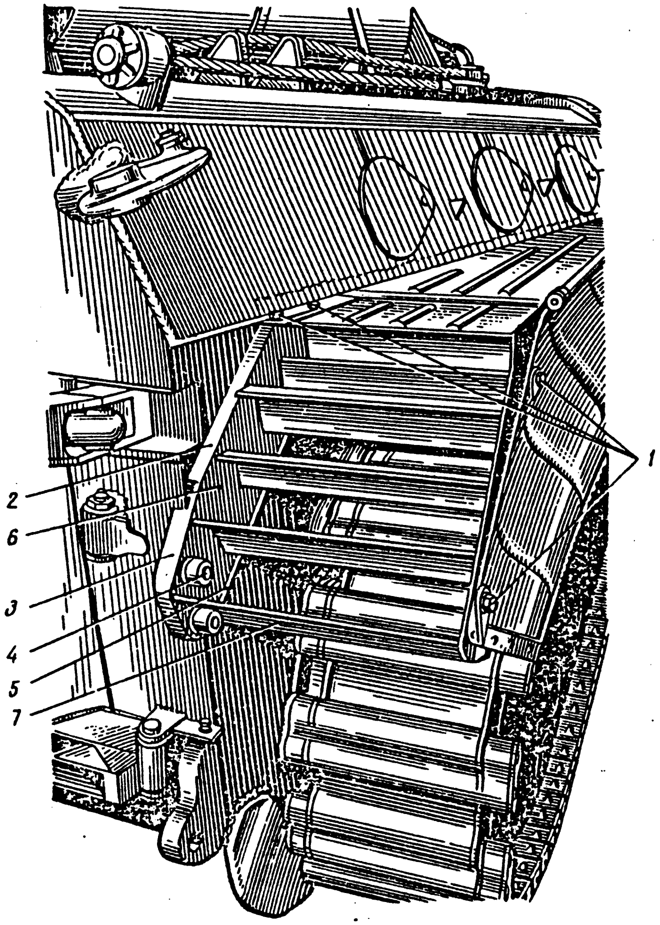

FIG.23. FASTENING OF GUIDE VANES

1, 4 - bolts; 2, 5 - guide strips; 3 - bracket; 6 - guide vanes sector; 7 - vanes

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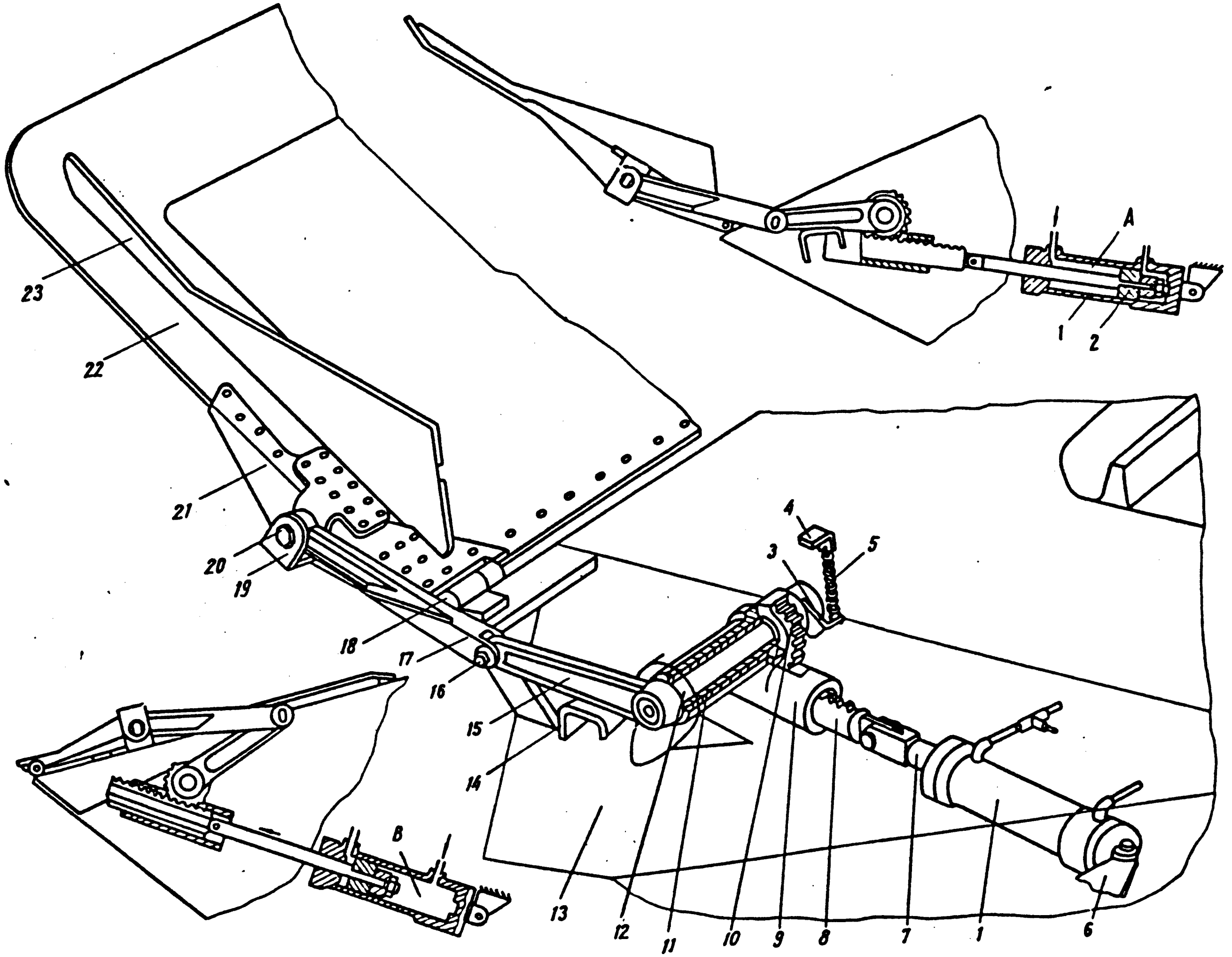
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FIG.24. SPLASH PANEL

1 - pneumatic cylinder; 2 - piston; 3 - lever; 4 - angle; 5 - spring; 6 - bracket; 7 - piston rod; 8 - rack; 9 - rack bracket; 10 - toothed sector; 11 - bushing of sector axle; 12 - sector axle; 13 - upper sloping plate of vehicle hull; 14 - stop; 15, 17 - levers; 16 - pin of levers hinge; 18 - splash panel hinge; 19 - bracket; 20 - panel

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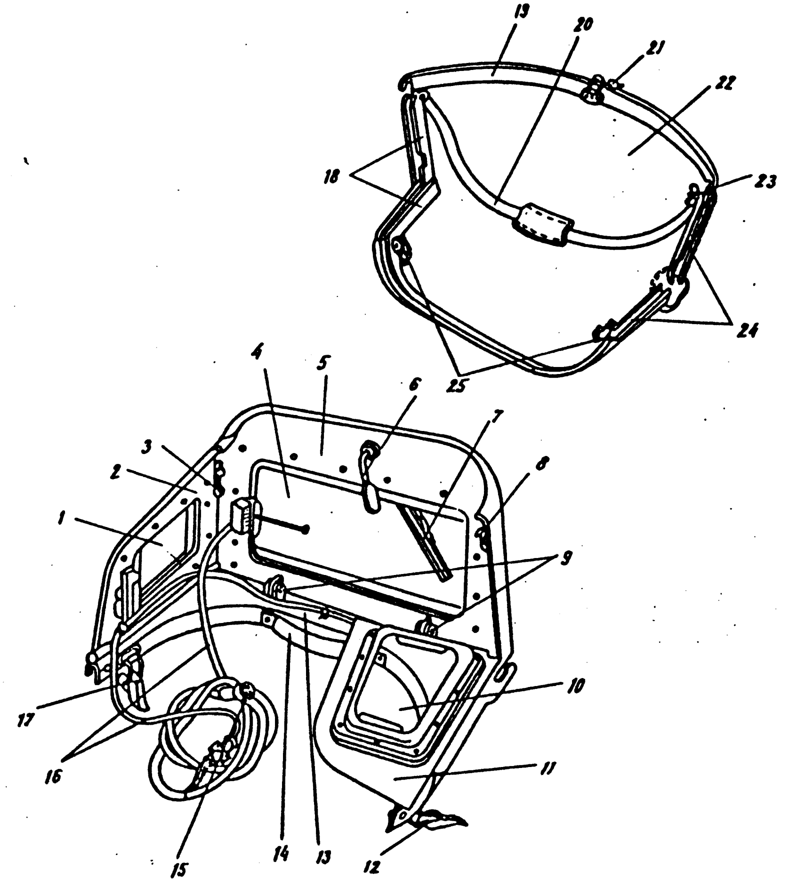
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FIG.25. DRIVER'S PROTECTIVE HOOD

1, 10 - side glasses; 2, 11 - side shields; 3, 8 -hooks for fastening of side shields; 4 - front glass; 5 - front shield; 6 - glass wiper handle; 7 - glass wiper; 9 - hinges; 12, 17, 21, 25 - locks fastening hood and shields; 13 - shield base; 14 - shock absorber; 15 - receptacle; 16 - heating system cables; 18, 24 - rims of canvas canopy; 19 - canopy base; 20 - spreader strap; 22 - canvas canopy; 23 - wing nut

[redacted]

The front glass is furnished with glass wiper 7, operated by handle 6. The protective hood is installed above the driver's hatch and is secured by means of locks 12, 17 and 21. The canvas canopy is fastened to the sides by locks 25 and hooks 3 and 8.

The glass electric heating is provided from the vehicle mains through cables 16 and plug connector receptacle 15.

2.3. TURRET

2.3.1. General

The cone-shaped welded turret (Fig.26) is installed in the vehicle middle part on the ball support. Welded into the turret front part is a cast frame which has gun port 2 and machine gun port 4. Made in the turret roof are four rectangular wells 11 for mounting of vision devices, operator's hatch 8, ATGM feed hatch 5, periscopic sight mounting hole 12 and blower hole 7.

2.3.2. Turret Ball Support

The turret ball support (Fig.27) consists of upper race 1 and lower race 2 with 108 plastic balls placed in-between.

Aluminium cage 5 provides for uniform distribution of the balls along the turret race perimeter.

Upper race 1 is bolted to turret base plate 9 (Fig.26); lower race 2 (Fig.27) is secure to the hull under-turret plate.

Rubber packing rings 8 are placed under jointing surfaces of the races. Cut on the lower race is toothed rim 9 which is engaged with the gear of the turret traversing mechanism fastened to the upper race.

Rubber packing 3 is placed for sealing of the upper-to-lower race joint.

2.3.3. Turret Lock

The turret lock (Fig.28) serves for locking of the turret in travelling position.

The lock consists of housing 1 secured to the turret base plate to the left of the operator, insert 3 connected with the vehicle hull by means of the axles of the lock linkage rack 6, handle 2, levers 4 and 9, mandrel 12 with two spiral springs 5 fitted on it and shackle 7.

Steel rack 6 has a built-up caprone rim on which five teeth 10 are milled.

To lock the turret, push handle 2; in this case the handle lower end no longer holds lever 4 and the latter actuated by mandrel 12 (which is pressed by springs 5) turns around axle 13, moving along the upper end of lever 9.

Lever 9 turning about axle 8 moves rack 6, and its teeth are engaged with the teeth of the turret lower race. To unlock the turret, pull handle 2; in this case the handle lower end turns lever 4 compressing the spring. Lever 4 turns lever 9 and rack teeth 10 get out of meshing.

2.3.4. Turret Hatches

The operator's hatch (Fig.29) is located in the turret middle part and is closed with convex armour hatch door 10. The hatch door is fastened on two hinges 22 and has a hold-open retainer and a lock for closing. The wedge-type lock consists of handle 20 with tooth 1 which holds the hatch door in position after going under the edge of the turret roof.

For tight closing of the hatch door tooth 15 is wedge-shaped. Handle 20 is fitted on tetrahedral end of threaded shaft 17 and secured by nut 16. Tightness of the hatch door closing may be adjusted by screwing threaded shaft 17 in or out, for which purpose lock handle 20 must be previously removed. Milled on the upper end of threaded shaft 17 is shaped slot "K" for the key opening the lock from the outside.

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For tight closing of the hatch door tooth 15 is wedge-shaped. Handle 20 is fitted on tetrahedral end of threaded shaft 17 and secured by nut 16. Tightness of the hatch door closing may be adjusted by screwing threaded shaft 17 in or out, for which purpose lock handle 20 must be previously removed. Milled on the upper end of threaded shaft 17 is shape slot "K" for the key opening the lock from the outside.

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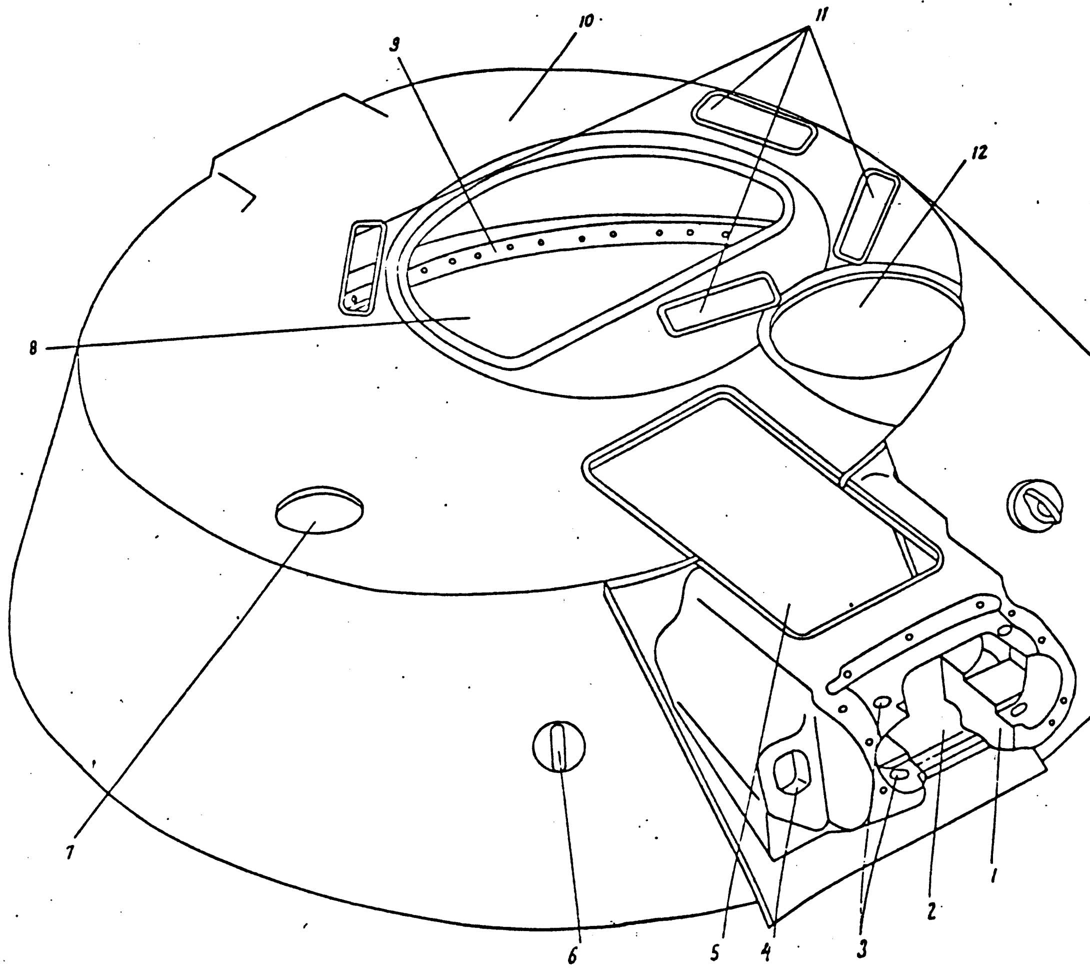

FIG.26. TURRET

1 - gun port cheek, 2 - gun port; 3 - holes for wedges, securing the gun trunnions; 4 - coaxial machine gun port; 5 - ATGM feed hatch; 6 - eye bolt; 7 - turret blower hole; 8 - operator's hatch; 9 - turret base plate; 10 - turret roof; 11 - wells of vision devices; 12 - sight mounting hole

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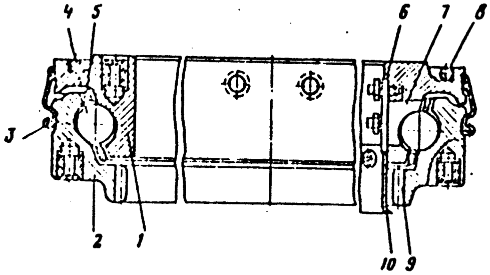

FIG.27. TURRET BALL SUPPORT

1 - upper race; 2 - lower race; 3 - ball support packing; 4 - ball; 5 - ball cage; 6 - cover of hole for insertion of balls; 7 - hole for insertion of balls; 8 - upper race packing ring; 9 - toothed rim; 10 - toothed rim guard

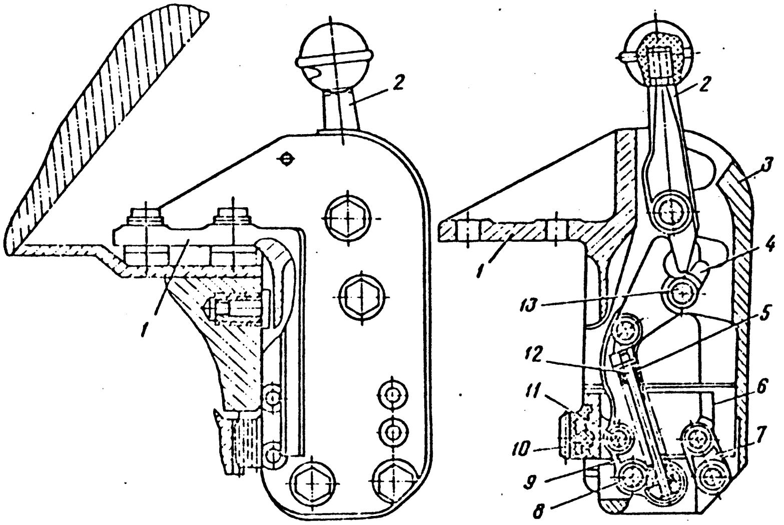

FIG.28. TURRET LOCK

1 - lock housing; 2 - lock handle; 3 - insert; 4 - forked lever; 5 - lock springs; 6 - rack; 7 - rack shackle; 8 - lever axle; 9 - lever; 10 - rack tooth; 11 - rack axle; 12 - mandrel; 13 - forked lever axle

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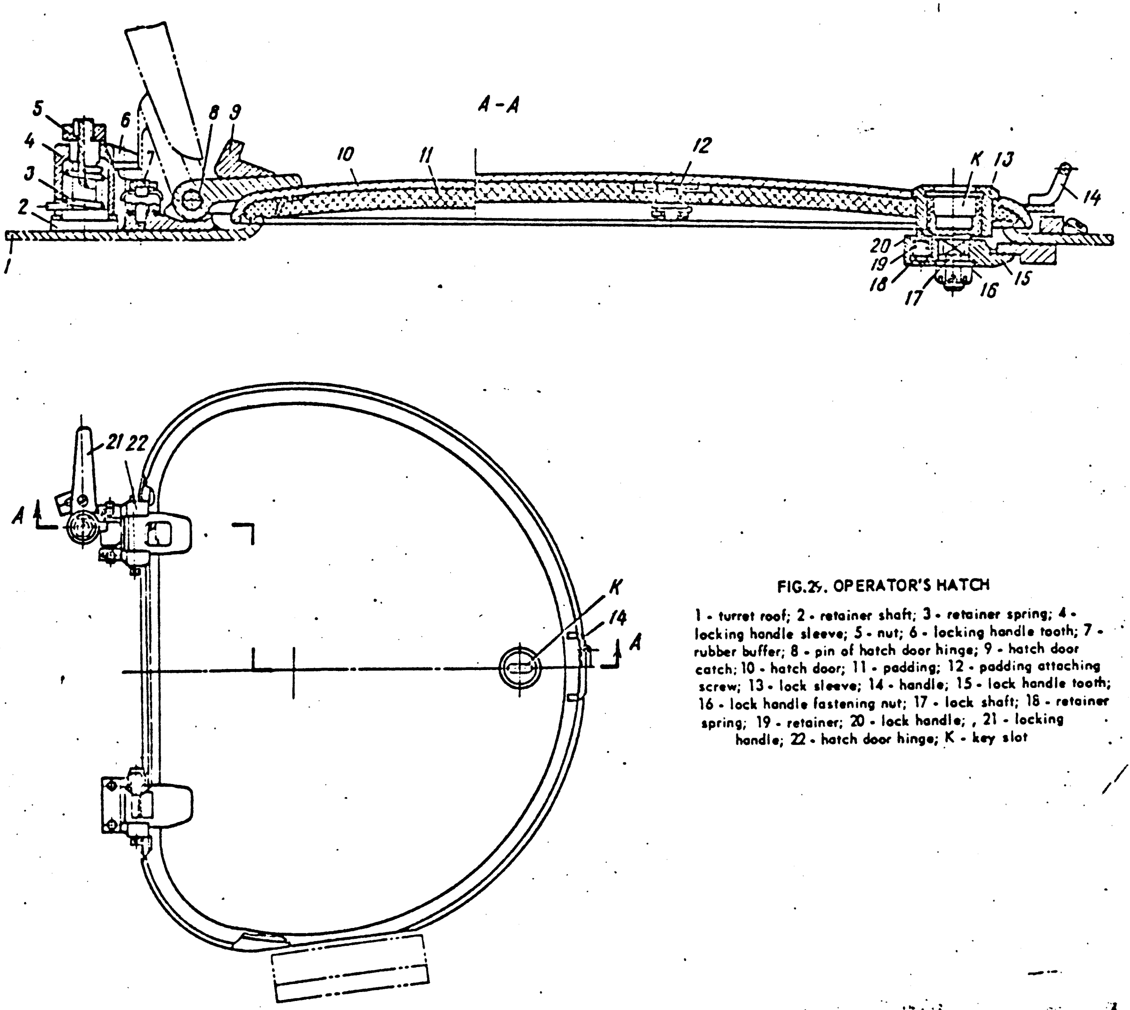
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FIG.29. OPERATOR'S HATCH

1 - turret roof; 2 - retainer shaft; 3 - retainer spring; 4 - locking handle sleeve; 5 - nut; 6 - locking handle tooth; 7 - rubber buffer; 8 - pin of hatch door hinge; 9 - hatch door catch; 10 - hatch door; 11 - padding; 12 - padding attaching screw; 13 - lock sleeve; 14 - handle; 15 - lock handle tooth; 16 - lock handle fastening nut; 17 - lock shaft; 18 - retainer spring; 19 - retainer; 20 - lock handle; , 21 - locking handle; 22 - hatch door hinge; K - key slot

[redacted]

and sleeve 4, and nut 9 fastening the handle on the shaft. Retainer spring 9 twists while operating.

Engagement of the hatch door by the retainer is provided by swinging it back until stop, in this case catch 9 presses tooth 6 of the locking handle, shifts it aside and the tooth, actuated by spring 3, snaps to engage the catch and will hold the hatch door.

To close the hatch door, push handle 21 (towards the turret rear) and disengage the retainer tooth from the catch. To facilitate disengagement, press the hatch door towards opening.

Packing of the hatch door is provided with a rubber gasket glued along its perimeter.

ATGM feed hatch (Fig.30) is rectangular. It is located in the front part of the turret roof above the gun port. The hatch is closed with armour hatch door 1 secured on two hinges and equipped with an opening and closing mechanism.

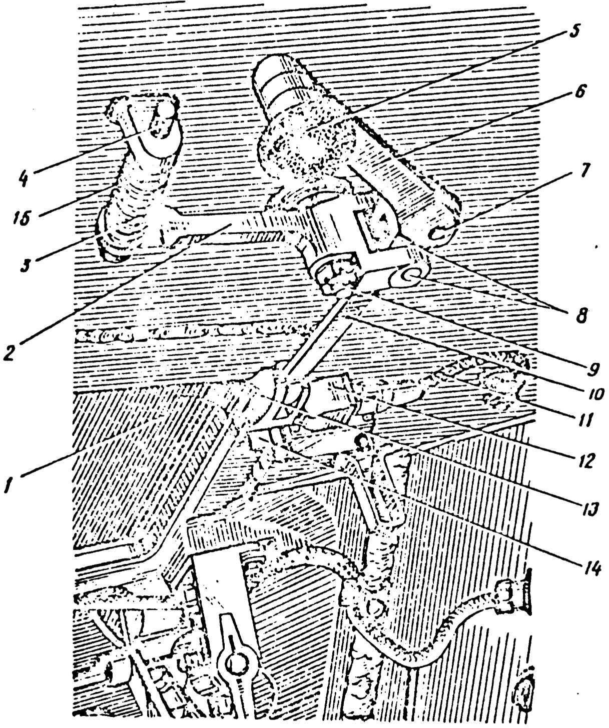

FIG.30. ATGM FEED HATCH

1 - hatch door; 2, 6 - levers; 3 - spring; 4 - adjusting screw; 5 - handle; 7 - rod pin; 8 - lever connecting pins; 9 - levers fixed axle; 10 - rod, 11 - electrical wire; 12 - limit switch, 13 - hatch door hinge; 14 - limit switch lever; 15 - locknut

A rubber packing gasket is glued on the hatch door inner side along its perimeter.

The lever-type hatch door opening and closing mechanism consists of hinge 13 welded to the door, rod 10, levers 2 and 6, adjusting screw 4 with spring 3 and handle 5 press-fitted into the eye of lever 6.

Lever 2 is fitted on axle 9 welded to the turret roof and its forked end receives adjusting screw 4 installed on which is spring 3. The other forked head of lever 2 is joined

[redacted]

Lever 2 with spring 3 serves as a damper. The linkage system provides for locking of the hatch door in extreme positions (open and closed).

The extent of the hatch door opening is adjusted by means of screw 4. To adjust, loosen locknut 15 and, rotating screw 4, adjust travel of rod 10. For signalling about open position of the hatch door rotary limit switch 12 is used. The switch is installed on the vehicle roof near hinge 13. During movement of rod 10 hinge 13 turns lever 14 of limit switch 12 and closes the pilot lamp circuit.

2.3.5. Crew and Troop Seats

The driver's and commander's seats (Fig.31) are similar in design, the difference between them being only in the method of fastening.

Both seats have soft cushion and backrest; the seat height and backrest inclination are adjustable. The driver's seat may be moved forward or backward as well. For this purpose, the seat base plate has longitudinal slots for bolts; after loosening these bolts it is possible to displace the plate together with the seat. The seat height is adjusted using a mechanism consisting of two strips 1 with grooves 2, bracket 12 with three pairs of pins 13 out of which the upper ones are joined with seat base 5, the middle ones fit into grooves 2 of strips 1 and the lower ones are secured in the plate brackets, two springs 11 and shaft 4 with two springs 14 slipped over the shaft, the seat height adjustment handle, two locks and lever 3 with stop 15.

To adjust the seat height, turn upwards handle 18 located on the seat right side. This will cause shaft 4 to turn and the locks release the shaft, allowing it to move along the slot of base 5. If the seat must be raised, the man must get up from the seat for a moment and the seat will be raised under the action of springs 11; if the seat must be lowered, press it down. To lock the seat, return the handle in the horizontal position.

The seat backrest inclination adjustment mechanism consists of shaft 16 fitted on which are two levers 8 loaded with spiral springs 17, and two toothed sectors 9. The teeth of levers 8 are meshed with teeth of sectors 9.

To change the backrest inclination, press the levers to the backrest and displace the latter.

The operator's seat (Fig.32) consists of base 4 secured to which are the cushion and backrest 3, two concentric pipes 14 and 16, pedestal 19 secured with four screws to the turret floor, and guard 2.

The seat is adjustable in vertical and horizontal planes. For the height adjustment pipe 16 has four slots connected with a longitudinal slot accommodating pin 17, which joins pipes 14 and 16. A lug provided at the top of pedestal 19 houses retainer 12 locking the seat in horizontal plane.

To change the seat height, raise handle 5, as a result the retainer comes out of the slot of pipe flange 13, and turn the seat until the pin leaves the slot. Then set the required position of the seat in height, place it opposite one of the slots and turn the seat back, after which release the handle.

In each of the four fixed positions the seat may be turned to the right 40°. For this purpose raise retainer handle 11 and turn the seat. This causes retainer 12 to compress the spring and come out of the recess in the pipe flange. When the seat is returned to the initial position retainer 12 pushed by the spring enters the recess and handle 11 is lowered.

Attached on the left side under the operator's seat on bracket 9 is ATGM control panel 8. The panel is locked in travelling and combat positions by a spring-loaded retainer controlled

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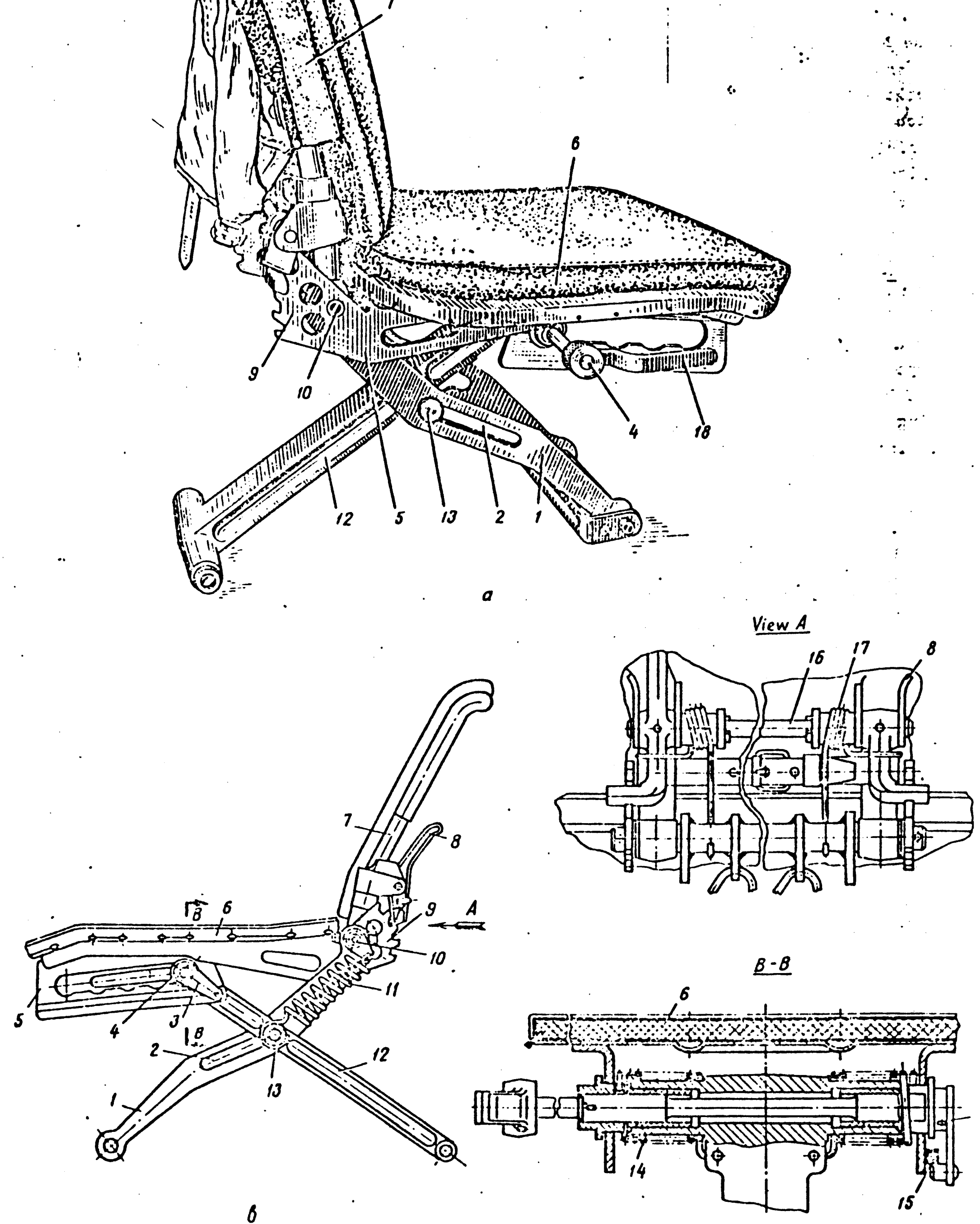
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FIG.31. DRIVER'S AND COMMANDER'S SEAT

a - general view; b - design

1 - front strip; 2 - groove in strip; 3 - lever; 4; 16 - shafts; 5 - seat base; 6 - seat cushion; 7 - seat back; 8 - seat inclination adjustment lever; 9 - toothed sector; 10 - pipe, 11 - spring, 12 - bracket; 13 - pin; 14 - shaft spring; 15 - stop; 17 - spiral spring; 18 - seat height adjustment handle

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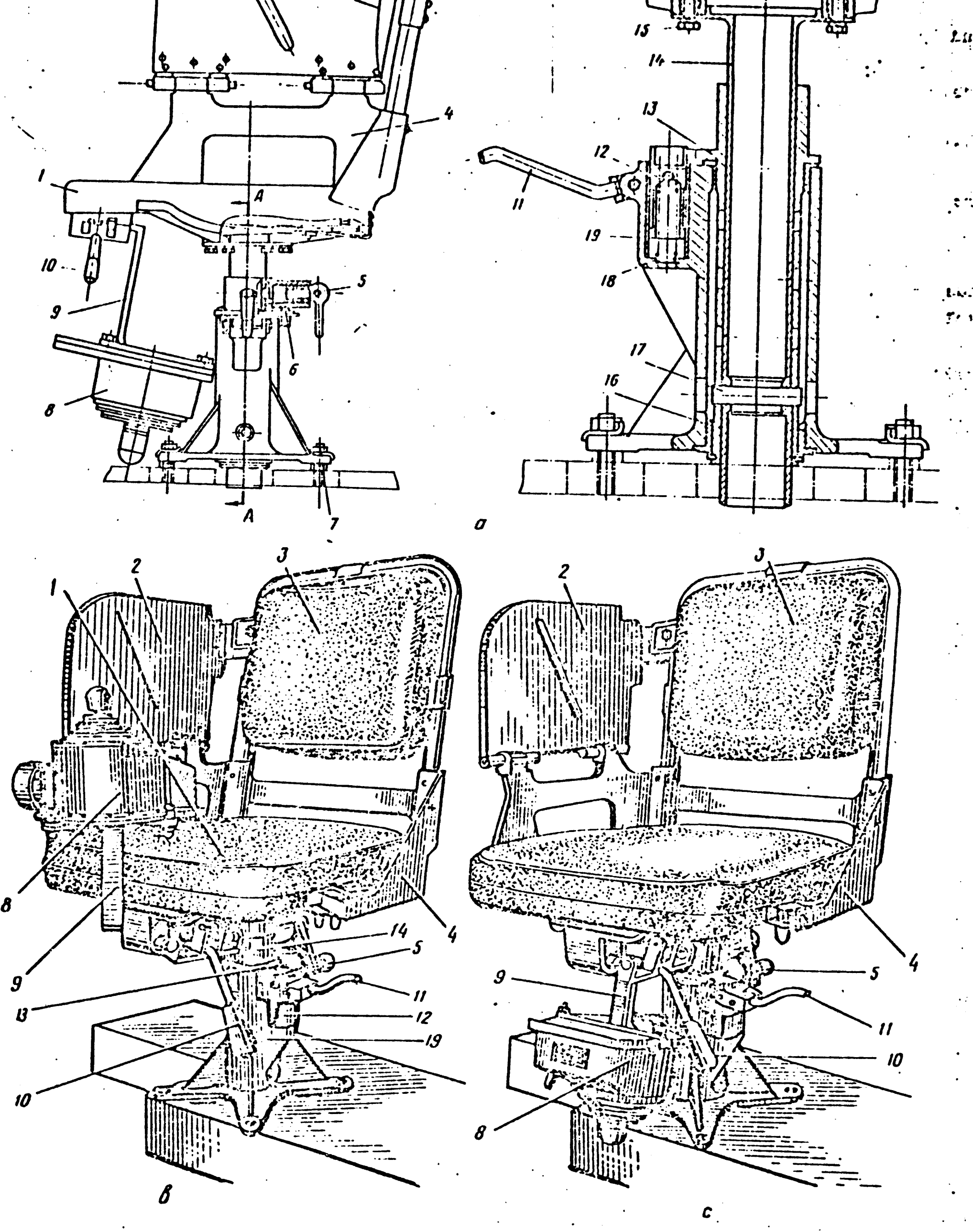
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FIG. 32. OPERATOR'S SEAT

a - seat design; b - seat with control panel raised; c - seat with control panel brought down; 1 - seat cushion; 2 - guard; 3 - seat backrest; 4 - seat base; 5 - handle of seat vertical position retainer; 6, 12 - retainers; 7 - seat attaching bolt, 8 - ATGM control panel; 9 - control panel attaching bracket; 10 - control panel locking handle; 11 - seat horizontal position retainer handle; 13 - flange; 14 - pipe; 15 - seat base attaching bolt; 16 - pipe with slots; 17 - pin; 18 - retainer spring; 19 - pedestal

[redacted]

Both troop seats are identical in design and are actually benches with soft cushions and backrests.

The seats have two positions - upper and lower, made by altering the positions of the posts supporting the seats.

The posts are two pipes welded at a 90° angle and hinged to the seat base. When the seat is placed on short posts its height is lowered and vice versa.

The posts are installed in tubular supports, welded to the vehicle bottom. The posts are locked in the supports by the retainers.

2.4. Care of Hull and Turret

Care of hull and turret includes the following operaions:

- periodic cleaning and washing;
- checking of the hatch doors and plugs for presence, tightness of closing and the gaskets and packings for condition;
- checking of locks and retainers of hull and turret hatch doors, engine compartment bulkhead hatch doors and seats for proper operation;
- checking the seat adjustment mechanisms for functioning;
- checking the rear doors for condition, for fuel leaks, the gaskets for condition and the locks, door locking mechanisms and hold-open locks for proper operation;
- checking of driver's hatch door locking mechanism for operation;
- checking of the splash panel and its control for proper condition and functioning;
- checking and adjustment of the ATGM feed hatch control;
- checking of the driver's protective hood for condition, the locks and glasses for good order and the heating system for operation;
- checking of the commander's hatch door for easy rotation and the retainer and locks for operation;
- periodic cleaning and lubrication of the locks, hinges, retainers and ball support of the commander's hatch door;
- checking of the fenders and guide vanes for condition.

2.5. Probable Troubles of Hull and Turret Mechanisms

Trouble	Cause	Remedy
Excessive effort is required to apply to the handles of rear door locks and troop compartment hatch doors	Penetration of dust in the locks	Wash the locks with diesel fuel
Penetration of dust, water and dirt in hull	Insufficient tightening of plugs, access hole covers and hatch doors of vehicle roof and bottom	Tighten plugs and bolts of access hole covers
	Faulty gaskets of plugs, covers and hatch doors	Replace gaskets
Failure of splash panel control	Insufficient air pressure in pneumatic system cylinder	Charge the cylinder
Excessive effort is required to open ATGM feed hatch door	Hatch door control is out of adjustment	Adjust, using adjusting screw 4 (Fig.30)

[redacted]

3. ARMAMENT

3.1. GENERAL

The turret of infantry combat vehicle mounts a 73-mm smoothbore semi-automatic gun and a coaxial machine gun. The barrel and the armour shield of the gun mount a bracket used for launching antitank guided missiles 9M14M.

In the troop compartment of the vehicle there are fixtures for seven submachine guns and two machine guns.

In addition, a space is provided above the fuel tank for installing portable antiaircraft missile system 9K32.

The vehicle is provided with stowage places for ten hand grenades Ф-1 and a flare pistol with 12 flares.

3.2. 73-mm GUN 2A28

3.2.1. Purpose and Design

The gun (Fig.33) is used to destroy enemy tanks and other armoured targets, as well as to neutralize fire means in cover.

The gun consists of barrel 1 with breech ring 10, carriage 1 (Fig.34), hydraulic recoil mechanism 5 (Fig.33), front nut 2, split ring 3, piston 17, two closing mechanisms 12, separator 9 and two trunnions 16 with needle bearings and wedge-type fastenings located in the turret port.

The barrel is a smooth bore monoblock. Its rear portion is threaded externally to receive the breech ring. The barrel end face has two recesses for the extractors and a slot for the firing pin to pass when the breechblock is opened and closed.

The carriage (Fig.34) is designed to hold together all the gun components and to mount the gun in the combat vehicle. It is an intricately-shaped casting which houses the hydraulic recoil mechanism. Key 15 is welded in the carriage lower portion to hold the hydraulic recoil mechanism against rotation in the carriage. The key houses a spring-loaded contact ensuring reliable electric connection of the carriage body with the breech ring body, which is required for the trouble-free operation of the electric primer. Toothed sector 4 of the gun elevating mechanism is secured to the left wall of the carriage. Camplates 11 and 35 intended to direct the breechblock motion during recoil and counterrecoil are installed at the rear on both sides of the carriage.

A platform with threaded holes for launcher attachment is located on the top.

Cylindrical trunnions 16 serving to secure the gun in the turret are located at the middle of the carriage.

The hydraulic recoil mechanism (Fig.35) serves to absorb the recoil energy and thus to ensure the required recoil length and to return the gun moving parts to their initial position after a shot is fired.

The hydraulic recoil mechanism is concentrically arranged around the barrel. It consists of inner cylinder 6, outer cylinder 2, piston 7 with four rubber obturating rings, and spring 5.

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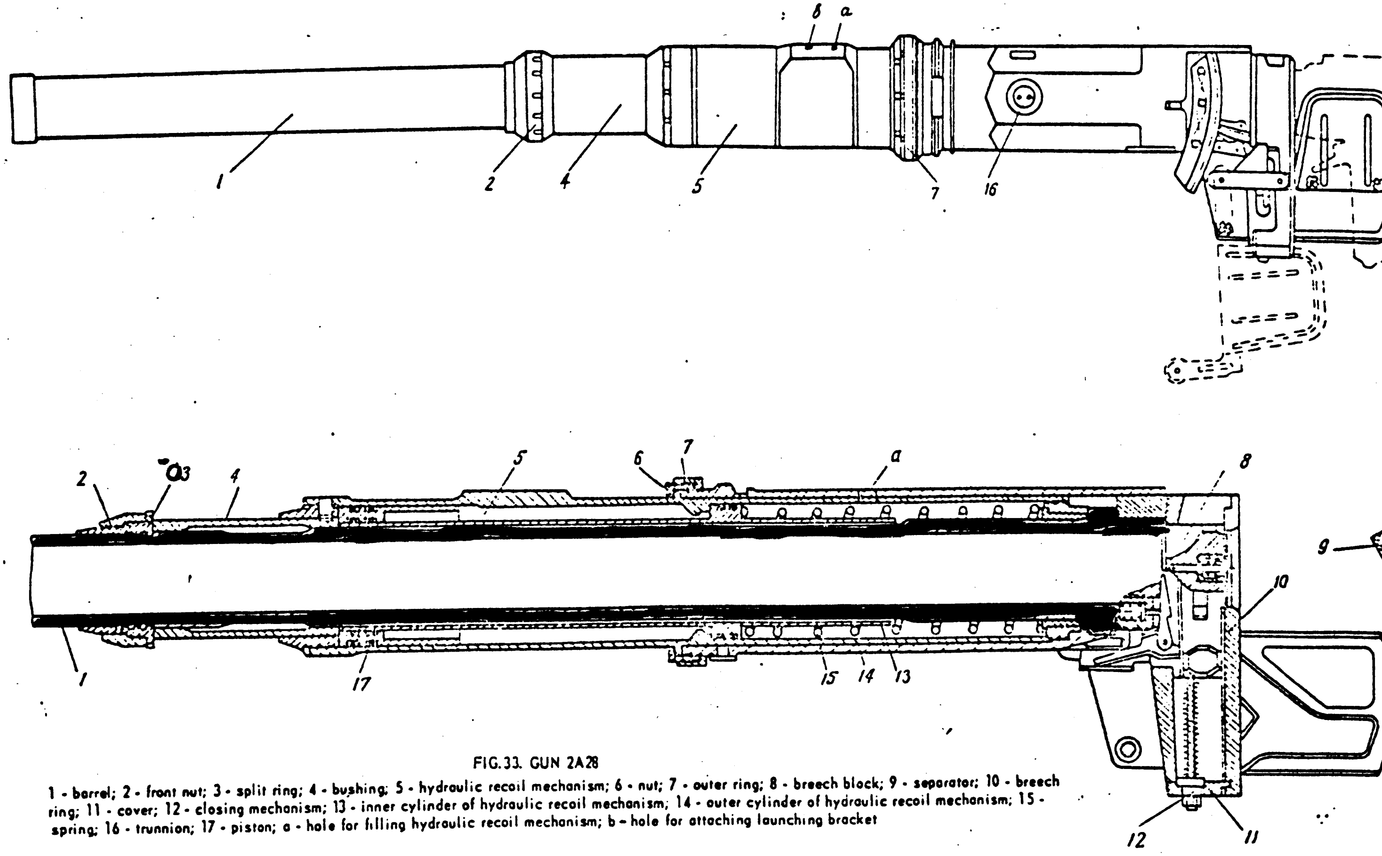

FIG.33. GUN 2A28

1 - barrel; 2 - front nut; 3 - split ring; 4 - bushing; 5 - hydraulic recoil mechanism; 6 - nut; 7 - outer ring; 8 - breech block; 9 - separator; 10 - breech ring; 11 - cover; 12 - closing mechanism; 13 - inner cylinder of hydraulic recoil mechanism; 14 - outer cylinder of hydraulic recoil mechanism; 15 - spring; 16 - trunnion; 17 - piston; a - hole for filling hydraulic recoil mechanism; b - hole for attaching launching bracket

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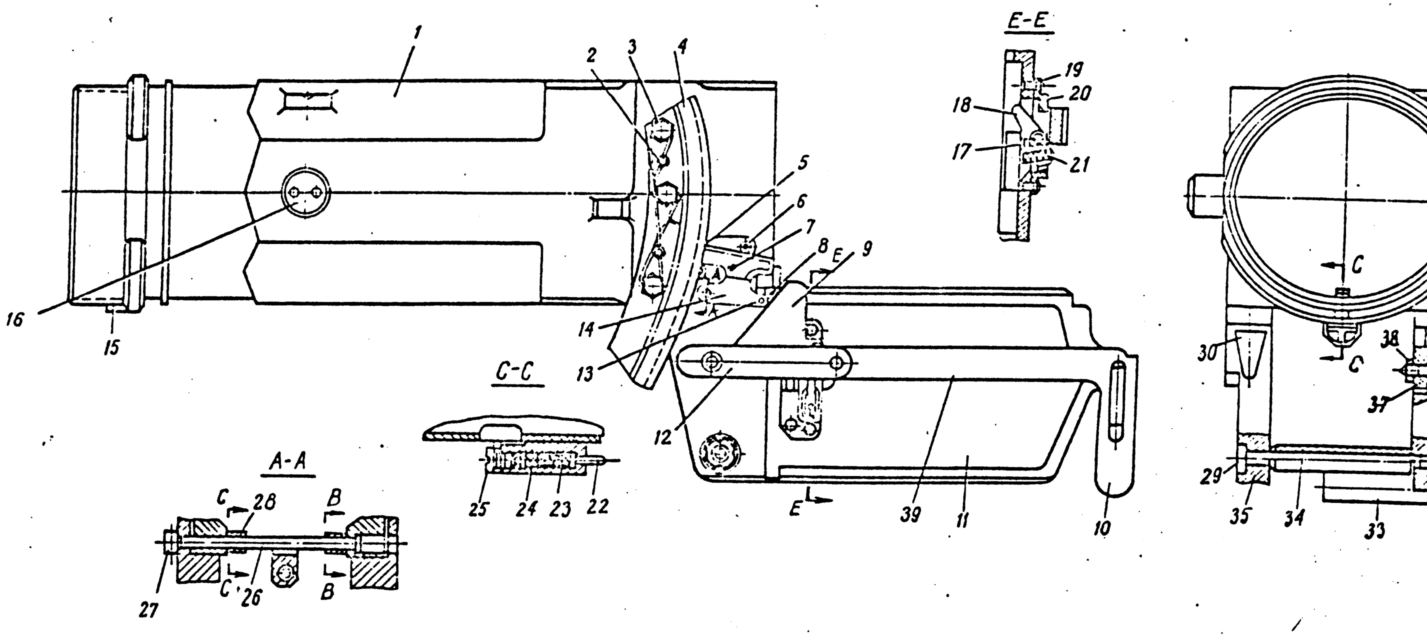
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23
22
A-A
C
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B
27
C'
26
B
E
39
11
10
C
C
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38
37
29
35
34
33

FIG.34 CARRIAGE

1 - carriage; 2, 6, 7, 13, 27 - lockpins; 3 - bolt; 4 - toothed sector; 5, 12 - rods; 8 - roller; 9 - lug; 10 - lever with grip; 11 - left-hand complate; 14, 31 - levers; 15, 23 - keys; 16 - trunnion; 17 - rebound lock axle; 18 - rebound lock; 19 - rivet; 20 - rebound lock frame; 21 - rebound lock spring; 22 - contact; 24 - contact spring; 25, 30 - screws; 26 - axle; 28 - extractor lever; 29 - coupling; 32, 38 - nuts; 33 - grip; 34 - bushing; 35 - right-hand complate; 36 - washer; 37 - reloading lever; 39 - lever assembly

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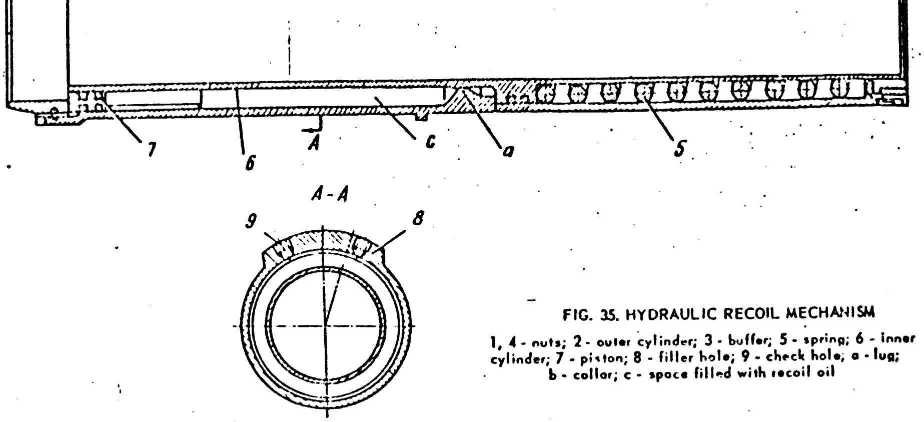

FIG. 35. HYDRAULIC RECOIL MECHANISM

1, 4 - nuts; 2 - outer cylinder; 3 - buffer; 5 - spring; 6 - inner cylinder; 7 - piston; 8 - filler hole; 9 - check hole; a - lug; b - collar; c - space filled with recoil oil

In its middle portion the inner cylinder has a collar. Annular grooves are machined in the collar to hold sealing rings. The recoil oil (1.3 lit of polyethylsiloxane liquid ПЭС-3, GOST 13004-67, is filled into space "c" formed between the inner and outer cylinders. At the ends the space is limited by piston 7 and collar "b" of the inner cylinder. One end of spring 5 bears against nut 4 screwed into the outer cylinder and the other end, against collar "b".

During recoil the hydraulic recoil mechanism operates as follows. When a shot is fired the barrel recoils together with split ring 3 (Fig.33) and bushing 4. Bushing 4 presses piston 7 (Fig.35) and the end face of inner cylinder 6, and displaces the parts backward, thus compressing spring 5. Outer cylinder 2 (which is rigidly connected with the carriage) remains in position. At the same time, piston 7 acts upon the recoil oil and forces it through the orifice between annular lug "a" of the outer cylinder and the inner cylinder into the rear space. The outer surface of the inner cylinder is shaped so that during the barrel travel the above orifice diminishes and the resistance to recoil increases. The normal recoil length varies within 130 and 150 mm.

After the recoil energy is absorbed, the inner cylinder and the barrel start to move forward under the action of compressed spring 5. Collar "b" presses the recoil oil to force it through the same orifice from the rear space into the front one, thus slowing down the counterrecoil.

The breechblock (Fig.36) serves to lock the barrel bore, fire the projectile and extract fired cartridge cases. It is located in the breech ring.

The breechblock is composed of the following parts:

- a breechblock wedge;
- a device for delivering electric current to the electric primer of the cartridge case
- a breechblock-position transmitter;
- a breechblock stop;
- a rebound lock mechanism;
- closing mechanisms;
- an extracting mechanism;
- a separator with an axle and retainer.

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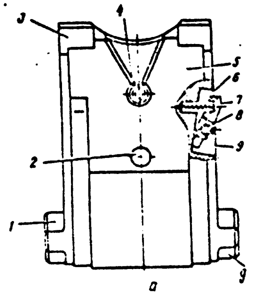
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5
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9
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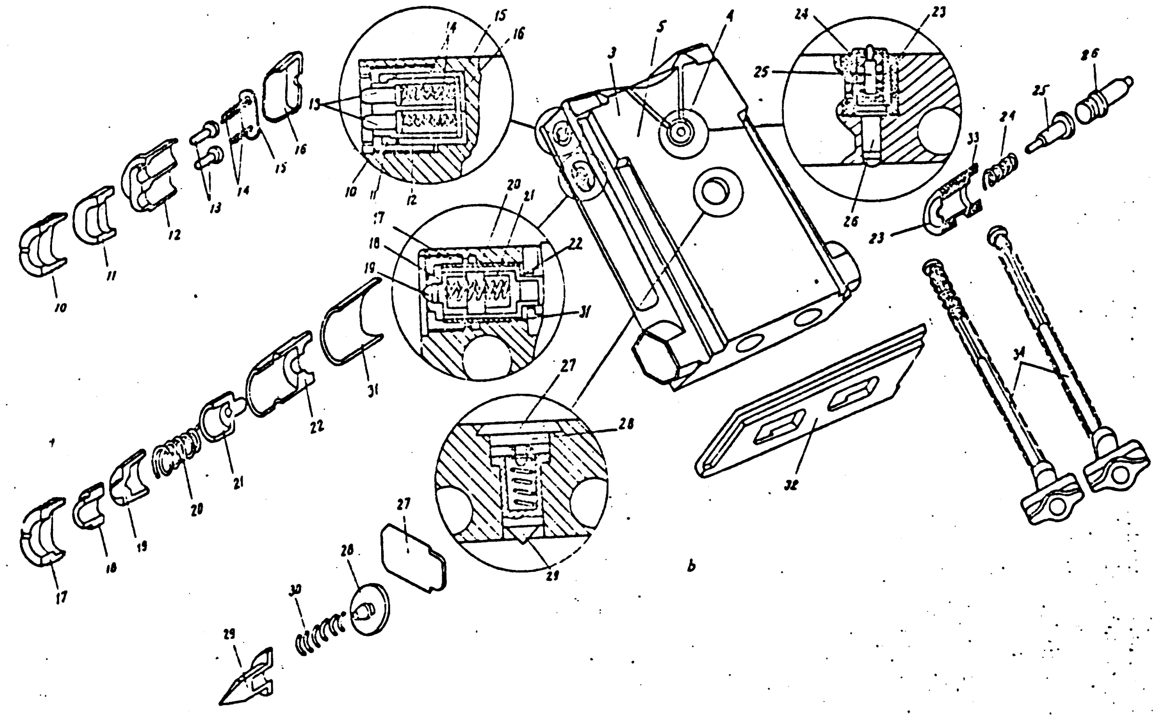
1
9
a

FIG.36. BREECHBLOCK

a - general view; b - breechblock parts and their arrangement; 1 - diamond-shaped lug; 2 - hole for cartridge case-to-body contact; 3 - bevel surfaces for engagement of breechblock with extractor hooks; 4 - firing pin hole; 5 - breechblock wedge; 6 - spring of stop; 7 - breechblock stop; 8 - stop axle; 9 - slot for stop; 10,17 - nuts; 11,15 - insulating washers; 12,22 - bushings; 13 - transmitter contacts; 14 - transmitter spring; 16 - bushing; 18 - insulating bushing; 19,21 - contacts; 20 - spring of contact; 23 - sleeve; 24 - spring of electric firing pin; 25 - pusher; 26 - electric firing pin; 27 - cover; 28 - plunger; 29 - breechblock body contact; 30 - spring; 31 - sleeve; 32 - breech ring cover for breechblock retention, 33 - insulating bushing; 34 - closing mechanism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b

[redacted]

vertically under the action of the shaped slots.

The wedge body has cuts and holes to accomodate the breechblock mechanisms.

The device for delivering electric current to the electric primer consists of electric firing pin 26 located in hole 4 of the wedge, sleeve 23, spring 24 of the firing pin, pusher 25 and adapter contact installed in a socket on the breechblock right side.

The adapter contact consists of two cylindrical contacts 19 and 21 fitted into bushing 22 insulated from the breechblock body. Installed between the contacts is spring 20 which presses contact 21 against sleeve 23, and contact 19 against the adapter block central contact.

Current is supplied from the vehicle mains to the round cartridge case (at the instant the trigger is pressed) as follows:

from adapter block contact to contact 19, through spring 20, contact 21 and bushing 22 to sleeve 23, from the sleeve through spring 24, pusher 25 to electric firing pin 26, and from the electric firing pin to the electric primer of the round cartridge case.

Contact 29 installed in central hole 2 at the wedge rear wall is provided to ensure reliable contact between the round cartridge case and the breechblock body. Contact 29 is pressed by plunger 28 and closed by cover 27.

The breechblock-position transmitter consists of metal bushing 12 accomodating two contacts 13 pressed by springs 14. Bushing 12 is insulated from the breechblock body by means of bushing 16 and washer 11. The transmitter is mounted in the hole located in the upper portion of the wedge right wall. It is secured by nut 10.

The breechblock stop prevents the breechblock from moving up from its lower position during counterrecoil. It is mounted in the slot on the side wall of the wedge. The stop is fitted on axle 8 and pressed by spring 6. During recoil the breechblock moves 70 mm down, and under the action of spring 6 stop 7 snaps into the longitudinal slot of the left-hand camplate of the carriage to hold the breechblock against upward motion.

At the beginning of counterrecoil the breechblock is held against upward motion by stop 7; then, under the action of the camplate slots it moves down 18 mm more and the stop goes out of the left-hand camplate to give way to the upward motion of the breechblock.

The breechblock is held in this position by the hooks of the extractors snapping behind the wedge bevel surfaces as a result of striking against the arms of extractors by the moving-down breechblock.

The breechblock closing mechanisms (Fig.37) serve to elevate the breechblock to the bore locking position. Both closing mechanisms are similar in design and consist of handle 6 fitted on guide bushing 4 and secured by lockpin 7, rod 3 with threaded portion "a" and head "b", spring 1 and nut 2. Rod 3 slides in bushing 4 and is held in it against falling-out by head "b".

Closing mechanisms 12 (Fig.33) are fitted into the wedge holes from below and secured by cover 11.

The closing mechanisms operate as follows.

During recoil, the breechblock lowers under the action of the camplates and compresses springs 15 the lower end of which bears against cover 11 mounted in breech ring 10. When the gun is loaded and the extractor hooks do not thrust against the breechblock bevel surfaces any longer, springs 15 expand and elevate the breechblock.

The rebound lock mechanism is designed to eliminate the breechblock rebound after it strikes against the breech ring inserts and to retain the breechblock in the upper position. It consists of rebound lock frame 20 (Fig.34), rebound lock 18 fitted on axle 17, and spring 21. The rebound lock mechanism is mounted on the left-hand camplate of the carriage.

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Lever 14 serves to return the extractor levers to their initial position.

A spring with rod 5 is installed in the hole drilled in the lever body. The rod is free to move axially and is held against falling-out by lockpin 7.

The rebound lock mechanism operates as follows.

With the wedge in the upper position, the upper arm of rebound lock 18 enters the slot of left-hand diamond-shaped lug 1 (Fig.36) of the wedge under the action of spring 21, and holds the wedge against lowering.

When the breechblock is opened manually, grip 33 (Fig. 34) turns and lever 10 lowers. The inner surface of lever 10 engages rebound lock 18, turns it about axle 17 and compresses spring 21. The rebound lock disengages the diamond-shaped lug and the breechblock is free to move down.

During firing the rebound lock goes from under the diamond-shaped lug of the wedge under the action of the sloping surface of the diamond-shaped lug slot when the barrel recoils together with the breechblock.

The extracting mechanism (Fig.38) is designed to extract fired cartridge cases, withdraw the round and keep the breechblock in the lower position. It consists of two extractors 11 mounted on axle 10 which is secured in the breech ring, two extractor levers 2 rigidly connected to axle 10, two concentrically arranged springs 4 and 5, and guide rod 6. Each extractor is a three-arm lever. Arm 7 engages the cartridge case rim and its hook 8 keeps the breechblock in the lower position. When the breechblock is opened, its bevel surface acts on arm 9. As a result, the extractor turns about axle 10 and extracts the cartridge case by arm 7. Arm 1 serves to interact with extractor levers 2 when the breechblock is opened manually.

Springs 4 and 5 continuously press arms 7 of the extractors through guide rod 6 against the breechblock front surface, thus excluding accidental slipping of the breechblock from hooks 8 of the extractors.

The extracting mechanism operates as follows.

When the gun is loaded manually and the breechblock moves down under the action of springs 4 and 5, the extractors turn and hooks 8 snap behind the upper bevel surfaces of the breechblock to hold it in the lower position.

When the gun is loaded, the cartridge case rim strikes against arms 7 of the extractors and turn the extractors on axle 10 counter clockwise. Hooks 8 of the extractors disengage the breechblock bevel surfaces and the breechblock is free to move up.

When the breechblock is closed without loading the gun, lug 13 (Fig.39) of lever 14 turns lever 12 counterclockwise. Axle 7 and levers 6 of the extractors fixed on it turn together with lever 12. Levers 2 (Fig.38) press arms 1 of the extractors, hooks 8 disengage the breechblock bevel surfaces and do not interfer with the breechblock upward motion.

At the beginning of counterrecoil after a shot is fired, the breechblock moves down under the action of slots of camplates by 18 mm more and its bevel surfaces strike against arms 9 of the extractors to turn them clockwise. As this occurs, arms 7 extract the cartridge case from the cartridge chamber.

The separator assembly consists of separator 9 (Fig.33), axle 6 (Fig.40) of separator, retainer 4, manual reloading lever, retainer spring 5, head 8 with thumbpiece 7, thumbpiece latch 11 with spring 12.

The separator axle is installed in the holes of the left-hand and right-hand camplates, which provides for an additional rigidity of their fastening. The axle carries the separator designed to guide the cartridge cases into the cartridge case collector when they are

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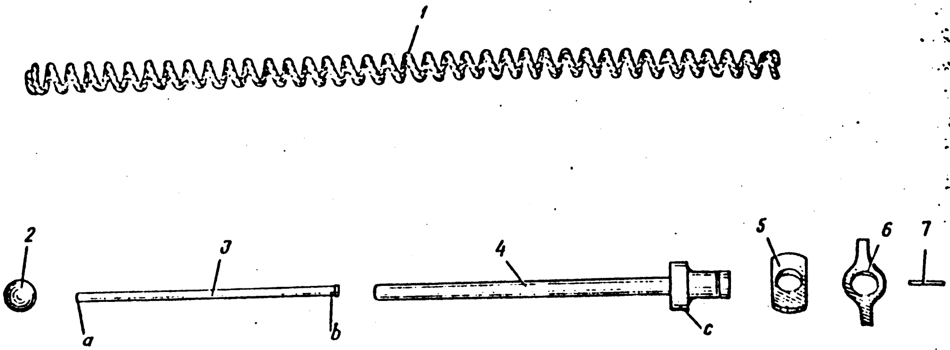

FIG. 37. CLOSING MECHANISM

1 - closing mechanism spring; 2 - nut, 3 - guide rod; 4 - guide bushing; 5 - insert; 6 - handle; 7 - lockpin; a - threaded portion of rod; b - rod head; c - bushing head

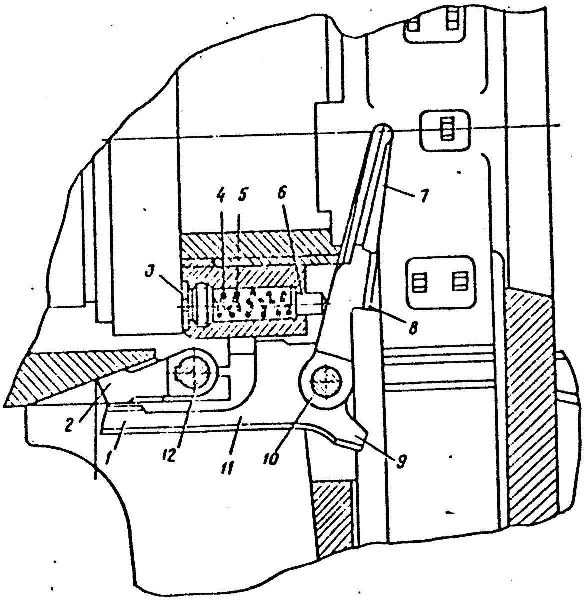

FIG. 38. EXTRACTING MECHANISM

1 - extractor longer arm; 2 - extractor lever; 3 - plug; 4 - inner spring; 5 - outer spring; 6 - guide rod, 7 - extractor upper arm, 8 - extractor hook; 9 - shorter arm; 10 - extractor axle; 11 - extractor; 12 - axle of extractor lever

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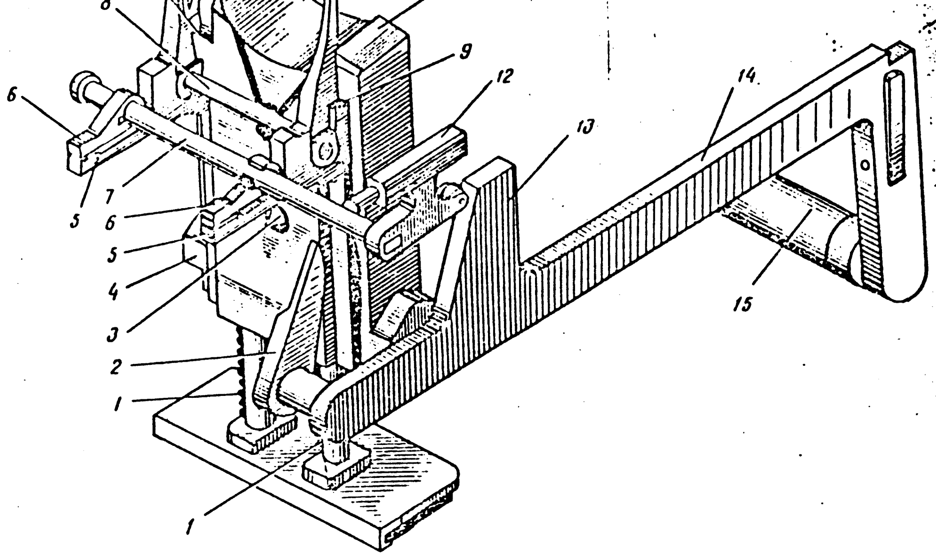

FIG. 39. INTERACTION OF BREECHBLOCK PARTS

1 - spring of closing mechanism; 2 - reloading lever; 3 - contact; 4 - diamond-shaped lug, 5 - extractor longer arm; 6 - levers of extractors; 7 - axle of extractors levers; 8 - axle of extractors; 9 - extractor hook; 10 - extractor upper arm; 11 - breechblock wedge; 12 - lever; 13 - lever lug; 14 - lever with grip; 15 - grip

extracted from the gun, and to secure the loading mechanism trough. Separator 2 is a bent plate with two bushings, installed into its holes, and springs 1 fitted onto the bushings. The separator is fitted onto axle 6 and is secured on it by means of springs so as to provide for an additional damping of the extracted cartridge case blow against the separator.

Retainer 4 mounted in axle 6 keeps the manual reloading lever in the initial position. It is installed in the axle hole on the side of head 8 and pressed by spring 5. The retainer is held against falling-out by lockpin 10. A longitudinal flat is made on the retainer to ensure its axial motion.

In the initial position manual reloading lever 10 (Fig.34) is located against head 8 (Fig.40) and fixed by retainer 4.

To open the breechblock, first press handle 33 (Fig.34) to the left and then lower it as far as it will go. Lever 10 will turn about its axle and disengage retainer 4 (Fig.40) from the lever. Then, return the handle to the initial position. Thumbpiece 7 serves to limit the upward motion of the manual reloading lever when the latter returns from the lower to the initial position.

If it is necessary to close the breechblock without loading the gun, turn thumbpiece 7 to the right as far as it will go, press handle 10 (Fig.34) to the left, withdraw the retainer from the lever and elevate the handle as far as it will go.

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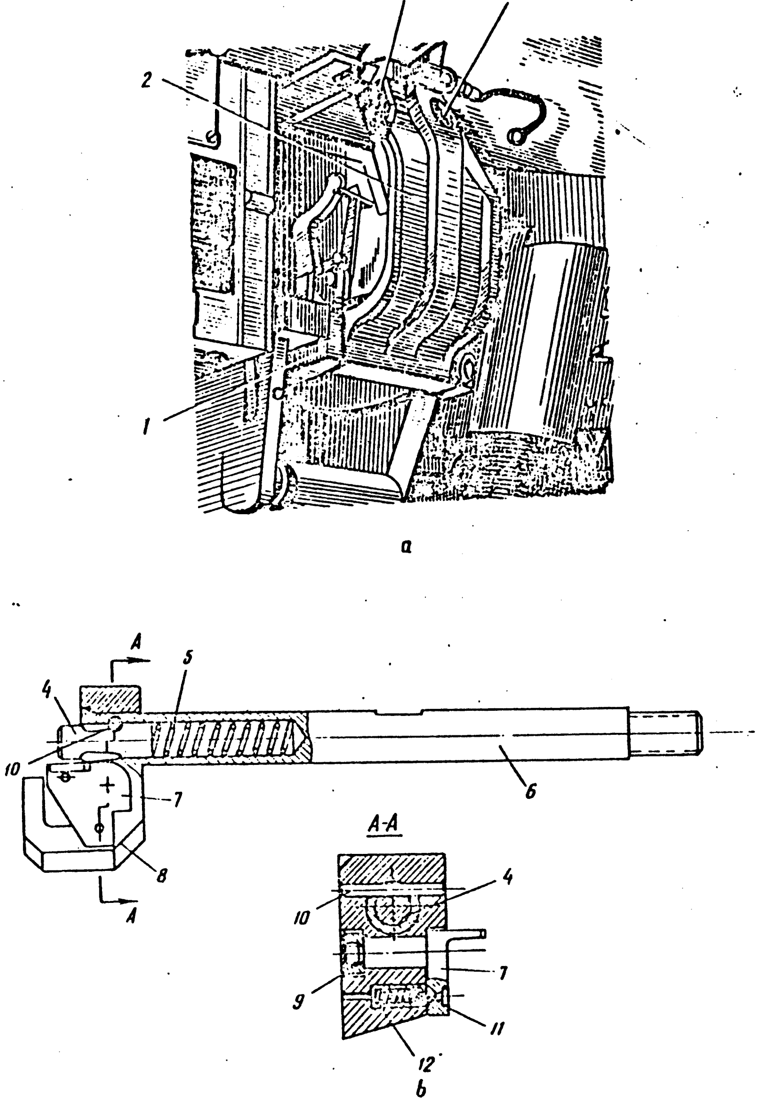
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8
A
A-A
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7
9
11
12
b

FIG. 40. SEPARATOR WITH AXLE

a - separator, b - separator axle; 1 - separator spring; 2 - separator; 3 - pad; 4 - retainer; 5 - retainer spring; 6 - separator axle, 7 - thumbpiece; 8 - head; 9 - nut; 10 - lockpin; 11 - latch; 12 - latch spring; c - hole for fastening through

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electrical system and duplicating generator. It is secured on the right side of the carriage.

The special connector consists of body 2, on which plug socket 4 is secured, insulator 10 with four spring-loaded contacts 1, and insulating cover 7. Each contact is connected with the respective contact of plug socket 4 by means of wires.

The circuit of the breechblock electric firing pin is energized from contact (1) of the special connector. The voltage supplied from the breechblock-position transmitters is taken from contacts (2) and (4).

The minus circuit runs from the electric primer to the cartridge case, barrel, carriage, and from the carriage to the key. Then, it goes through the contact mounted in the key to the breech ring, breechblock stop 7 (Fig.36), through axle 8 to breechblock wedge 5 and from the wedge to contact 29.

3.2.2. Gun Mount

The gun is installed in the turret gun port on trunnions 25 (Fig.42) supported by needle bearing. The bearing races are mounted in the gun port cheeks. Races 24 are secured by wedges 15 closed with plugs 4 from above.

Packing 5 serves to seal the gun mount-to-firing port joint. The packing is a cover fastened to the gun carriage by means of collar 17 and to the turret by means of plates and screws. The cover is stretched by three springs 7.

Armour shield 18 installed on the gun carriage is designed to protect the gun mount-to-firing port joint.

3.2.3. Gun Locking Mechanism

Electromechanical gun locking mechanism 21 is mounted on the breech ring. It serves to lock the gun when it reaches the loading angle. The mechanism consists of cylindrical body 5 (Fig.43) with lock 1 moving in it and pressed by a helical spring, lock latch 3, latch electromagnet 4 and lock electromagnet 6.

When the gun reaches the loading angle, the electric circuit of the limit switch is closed, and voltage is supplied to the winding of the electromagnet of gun lock latch 3.

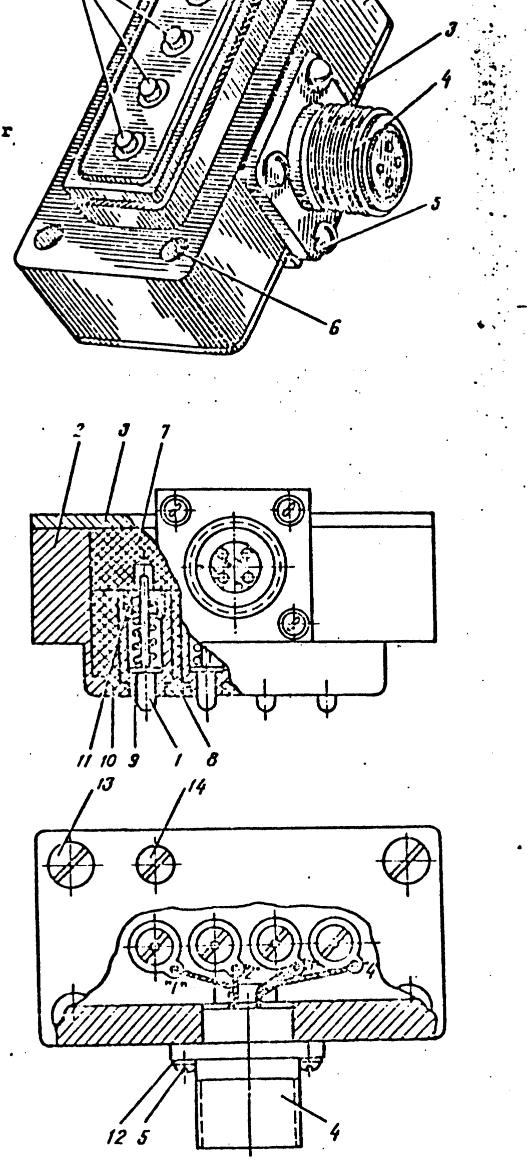

FIG.41. SPECIAL CONNECTOR

1 - contacts; 2 - body; 3 - cover; 4 - plug connector; 5 - screw; 6 - through hole to receive screw that fastens connector to carriage; 7 - insulating cover; 8 - bushing; 9 - spring; 10 - insulator; 11 - nut; 12 - spring washer; 13, 14 - screws

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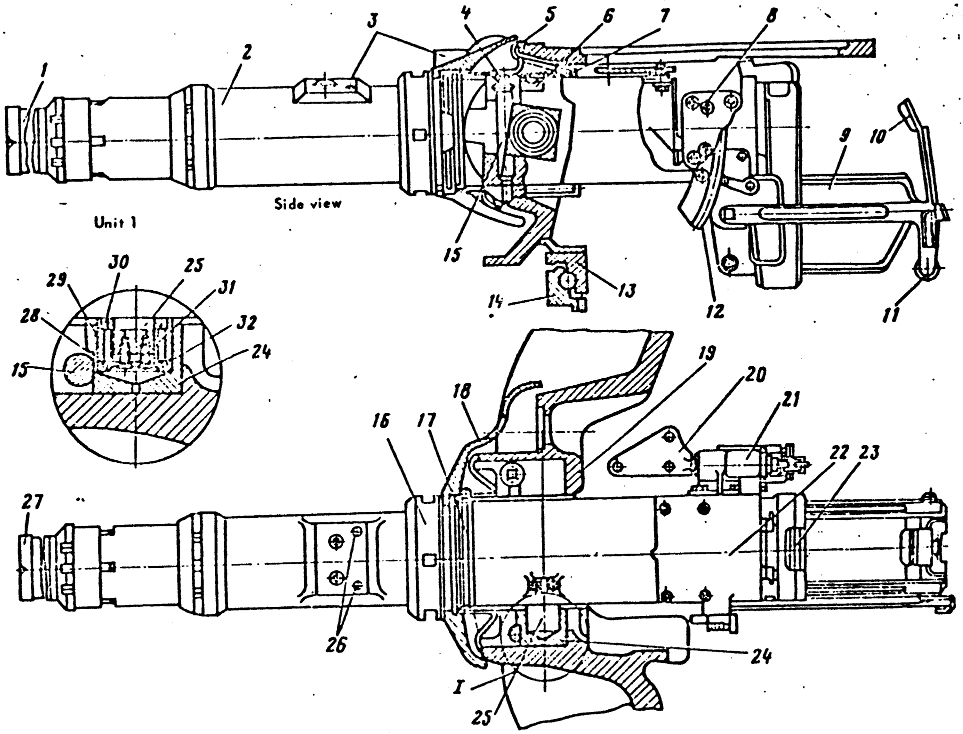
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Unit 1
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FIG. 42 GUN MOUNT

1 - barrel; 2 - hydraulic recoil mechanism; 3 - bosses for fastening launching bracket; 4 - plug for access to wedges; 5 - gun port packing; 6 - boss for fastening sight rod; 7 - gun port packing spring; 8 - gun lock bracket; 9 - complate of carriage; 10 - separator; 11 - lever with grip; 12 - toothed sector; 13 - turret upper race; 14 - turret lower race; 15 - trunnion fastening wedge; 16 - barrel clamping nut; 17 - barrel packing collar; 18 - armour shield; 19 - turret; 20 - bracket of lock socket; 21 - locking mechanisms; 22 - carriage; 23 - breechblock; 24 - trunnion holder; 25 - trunnion; 26 - filler plugs; 27 - rim; 28, 30 - trunnion packings; 29 - needle bearing; 31 - screw; 32 - ring

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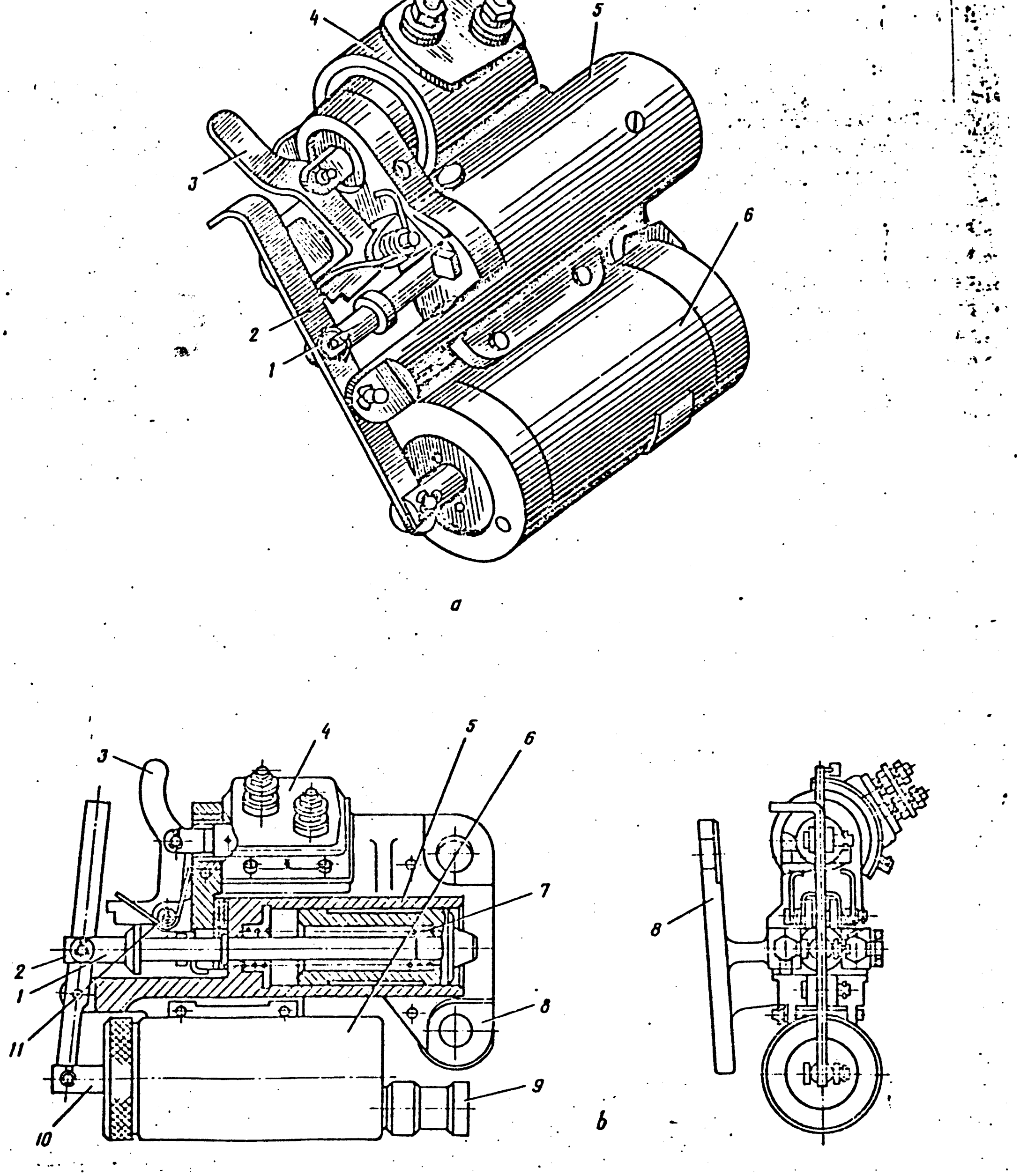

FIG.43 GUN LOCKING MECHANISM

a - general view; b - sectional view; 1 - gun lock; 2 - lever; 3 - latch; 4 - latch electromagnet (relay PII-1); 5 - body; 6 - lock electromagnet; 7 - lock spring; 8 - attachment flange; 9 - plug connector; 10 - electromagnet rod; 11 - latch spring

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to unlock the gun. Latch 3 fixes the lock under the action of the spring.

3.2.4. Gun Loading Mechanism

Design

The electromechanical loading mechanism (Fig.44) is a semi-automatic device.

It consists of a conveyer with a drive and a round feed mechanism.

The conveyer is designed to stow forty rounds and to move them to the supply line.

Frame 32 rigidly connected to turning floor 37 of the fighting compartment serves as a base of the conveyer. It consists of two half-ring guides 5 and 36 connected by a verticall wall. The frame together with the floor is attached through hinges 8 to the turret upper race by means of four ribs 7, a bracket and two rods 27. Ring 39 is mounted on the floor to prevent the floor from radial displacement. Three capron rollers mounted on the hull bottom in brackets 38 on the axles move along the floor ring and prevent the latter from displacement.

Two rows of seats 2 designed for securing the rounds are installed between the upper and lower guides of the frame on both sides of the vertical wall.

The seats are cylindrical yokes open at one side. Riveted to the upper portion of the yoke is a grip which keeps the round from falling out of the seat. The grip body mounts two guide rollers, thumbpiece 3 and wedge 4. Wedge 4 retains the round in the seat. The thumbpiece and wedge are pressed by springs fixed on their axles. Riveted to the seat lower portion is a carriage with three guide rollers.

The upper and lower rollers ensure free motion of the seats along the guides.

Two vertical shafts 28 rotate in ball bearings on both ends of guides 5 and 36. Two sprockets are fixed on each shaft. The sprockets engage the roller chains fastened to which are the seats. Upper chain 31 is secured to the seat grips by means of two axles 30, and the lower chain is fastened to the yoke bottom.

The chains coupling together all the seats form an endless conveyer belt. Right-hand shaft 35 is a driving element of the conveyer, and left-hand shaft 2 (Fig.45) is a driven element of the conveyer. Bearings 3 of the left-hand shaft are installed in oblong bores permitting to move the shaft.

Springs 6 of the tensioning device (which permits to change the tension of the chains by means of adjusting bolts 4) bear against the races of bearings 3.

A limit switch is mounted on upper guide 8 near the seat located at the initial position.

The conveyer drive consists of electric motor 5 (Fig.46), driving gear 6, driven gear 11 a disc-type friction clutch, worm 3, worm gear 13 riveted to which is splined shaft 14 of the drive, locking disc 15 fitted on splined shaft 14 and secured with a key, and an arresting device with electromagnet 4. Milled along the perimeter in locking disc 15 are three slots arranged at an angle of 120°.

Rotation is transmitted to the conveyer from electric motor 5 through gears 6 and 11 and friction discs 10 of the friction clutch to worm 3, worm wheel 13 and drive shaft 14. Then, rotation is transmitted from shaft 14 through coupling to shaft 28 (Fig.44), cardan joint 29 and the shaft of the driving sprockets.

The driving sprockets drive the roller chains and seats and together with them the conveyer.

The friction clutch protects the drive from damage in case the conveyer is jammed. It is mounted in the hub of driven gear 11 (Fig.46) whose the slots receive the lugs of three driving discs. The splined portions of three driven discs are fitted on the end of the worm shaft. The discs are compressed by the helical spring held by the thrust bushing and nut.

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the electromagnet by means of lever 1.

The retainer is designed to ensure a step-like motion of the conveyer.

In the initial position, retainer 16 is pressed against disc 15 and, being fitted in one of the three slots, locks the reduction gear of the conveyer.

As the conveyer is switched on, voltage is supplied to the winding of electromagnet 4 which draws in rod 2 and unlocks the reduction gear. To facilitate the unlocking, the electric motor is energized by reverse current at the moment the retainer comes out of the locking disc, and the electric motor shaft turns in reverse direction. When retainer 16 come out of the locking disc the chamfer on its outer surface pushes the ball, the ball presses on the button of the limit switch, thereby closing the circuit of electric motor 5. The electric motor starts to rotate in the normal direction to drive the conveyer. As soon as the seat with the round reaches the supply line, the round-presence on supply line limit switch gets closed and the electromagnet (ЭЛС-3) is deenergized. Retainer 16 is pressed against locking disc 15 under the action of spring 18 and enters one of the locking disc slots to lock the round in the initial position. At the same time (when the disc gets locked) ball 17 enters the slot of retainer 16 and releases the limit switch button thereby deenergizing electric motor 5.

The round feed mechanism serves to catch the round from the conveyer seat, lift it to the loading line and ram into the gun barrel. All units of the round feed mechanism are fastened on bracket 14 (Fig.44) located in the turret rear along the gun axis.

Bracket 14 has two side cheeks to mount the supports of the units. The bracket is an additional link connecting the turret with the fighting compartment floor.

The round feed mechanism is divided into the units serving to catch the rounds and deliver them to the loading line, and the rammer units.

The first group of units includes electric motor 10, lever drive reduction gear 9, driving (lower) levers 24, driven (upper) levers 23 and trough-catch 6.

The rammer mechanism consists of electric motor 15, reduction gear 13 and a rammer band,

The lever drive reduction gear (Fig.47) is actuated by electric motor 6. It ensures lifting and lowering of the round feed mechanism levers.

The reduction gear consists of a body, a pair of internal gears, a friction clutch, a shoe brake, electromagnet 10 (ЭЛС-3) and retainer 23 operated by handle 22.

Rotation is transmitted from the electric motor through the bushing which is fitted on the splined portion of the electric motor shaft, and guide strap 4 to friction discs 12 pressed to each other by the central spring.

From the friction clutch driven discs (whose lugs enter the slots of the brake drum) rotation is imparted to drum 5 and from its shank provided with a radial slot to the pin of eccentric shaft 15 rotating in two ball bearings installed in flange 16 and the hub of gear 1.

As eccentric shaft 15 rotates, the spur gear (which is fitted on it on ball bearing 18 and meshes with the inner teeth of interlocked gear 2) starts to run over gear 2. As this occurs, gear 2 rotates in the direction opposite to the rotation of eccentric shaft 15.

Bushings 19 and pins 20 fitted in the holes of the hub of gear 1 and flanges 16 and 24 rotate together with the gear and actuate flange 16 and output gear 14 made integral with it.

Bushings 19 are fitted in the holes of the hub of gear 1 with a large clearance (4 mm), which provides for radial displacement of the gear in relation to flanges 16 and 24.

The shoe brake serves to stop the reduction gear rotating parts after the electric motor is switched off. It consists of two shoes 3, levers 21, a pressure device, three-arm lever 9 and electromagnet 10. Electromagnet 10 is switched off at the moment the electric

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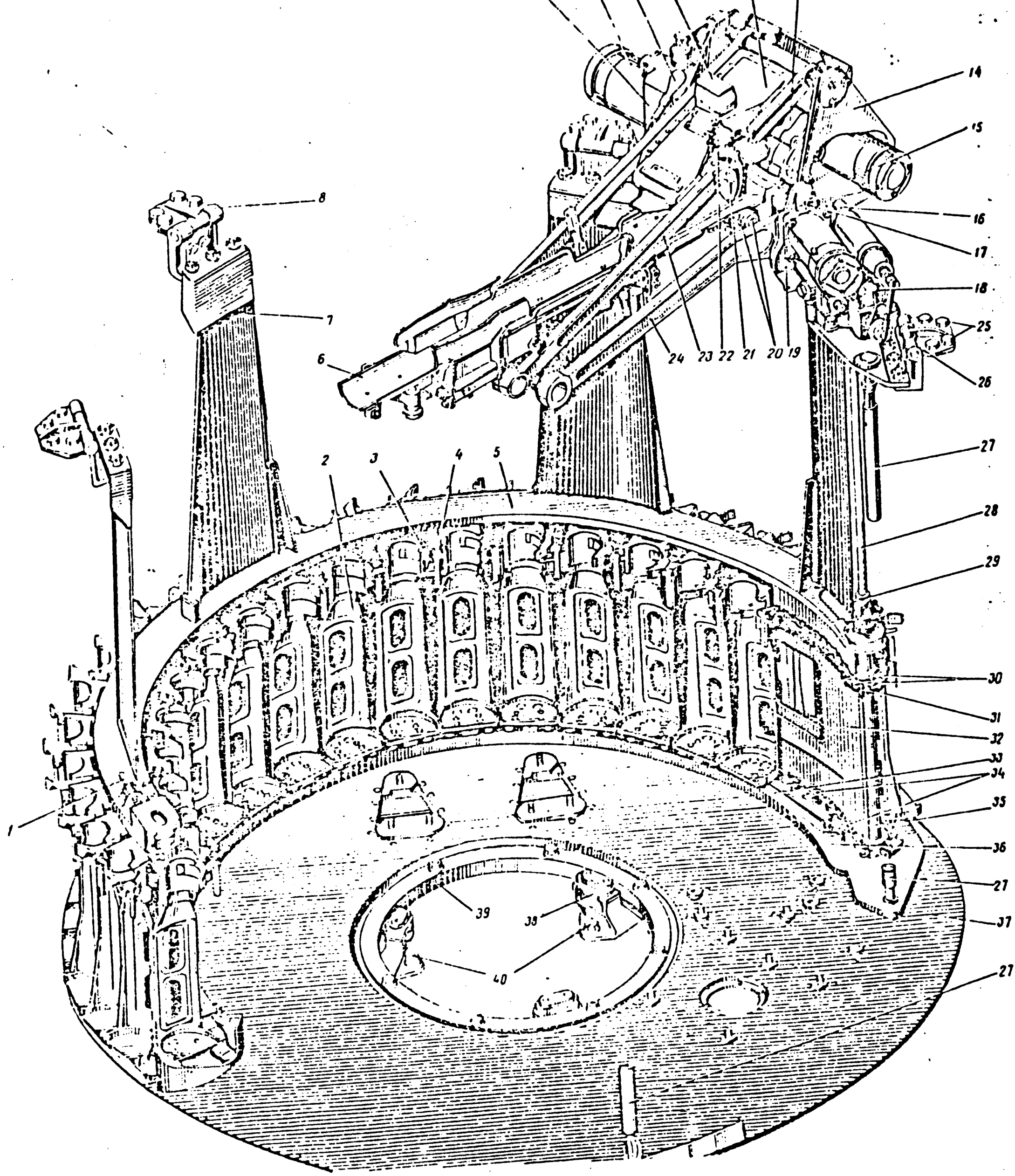

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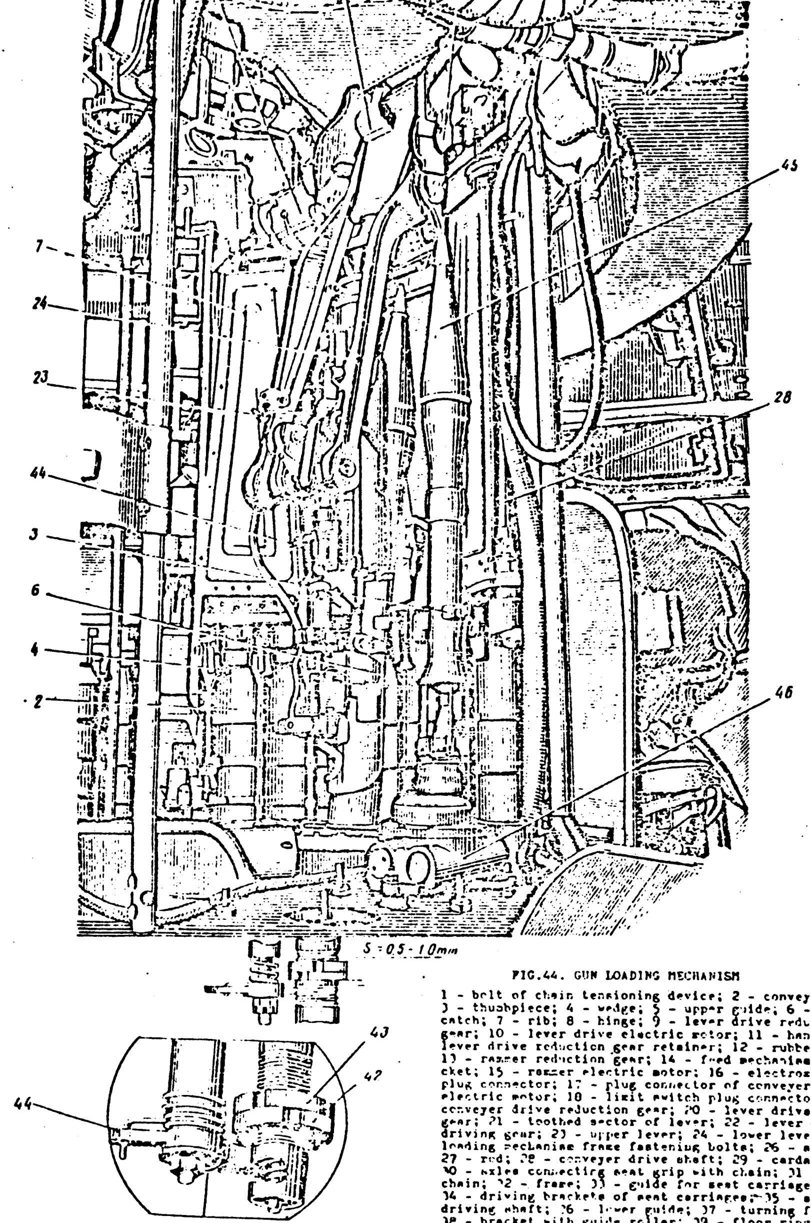

FIG.44. GUN LOADING MECHANISM

1 - bolt of chain tensioning device; 2 - conveyer seat; 3 - thumbpiece; 4 - wedge; 5 - upper guide; 6 - trough-catch; 7 - rib; 8 - hinge; 9 - lever drive reduction gear; 10 - lever drive electric motor; 11 - handle of lever drive reduction gear retainer; 12 - rubber stop; 13 - rammer reduction gear; 14 - feed mechanism bracket; 15 - rammer electric motor; 16 - electromagnet plug connector; 17 - plug connector of conveyer drive electric motor; 18 - limit switch plug connector; 19 - conveyer drive reduction gear; 20 - lever drive cluster gear; 21 - toothed sector of lever; 22 - lever drive driving gear; 23 - upper lever; 24 - lower lever; 25 - loading mechanism frame fastening bolts; 26 - strap; 27 - rod; 28 - conveyer drive shaft; 29 - cardan joint; 30 - axles connecting seat grip with chain; 31 - driving chain; 32 - frame; 33 - guide for seat carriage rollers; 34 - driving brackets of seat carriages; 35 - sprocket driving shaft; 36 - lower guide; 37 - turning floor; 38 - bracket with guide roller; 39 - floor ring; 40 - bolts for bracket fastening to vehicle bottom; 41 - sole plate; 42 - nut; 43 - locknut; 44 - lever of trough-catch pawls lock; 45 - dummy round; 46 - turret collector ring box

[redacted]

surface of gear 2 under the action of spring 29, and holds operation of the reduction gear when the electric drive is used.

To move the levers by hand, turn handle 22 downward withdrawing it from clips 28. In this case eccentric head 26 of the handle thrusts against the body groove to withdraw the lock from the epicyclic gear slot and disengage the reduction gear.

Driving (lower) levers 24 (Fig.44) are mounted so that their upper heads are supported by bearings in bracket 14. Riveted to the heads are toothed sectors 9 (Fig.48) connected with each other by means of shaft 10. Shaft 10 is integral with two gears 11 meshing with toothed sectors 9. The shaft serves to ensure simultaneous motion of both levers. It is installed in two ball bearings.

Right-hand toothed sector 9 has a larger number of teeth than the left-hand one. Same of its teeth are in mesh with output gear 14 (Fig.47) of the lever drive reduction gear, which actuates the round feed mechanism. Mounted on this sector is a camplate which interacts with the rod of the lever intermediate position limit switch.

The lower heads of driving levers 18 (Fig.48) are rigidly coupled with the splined shaft supported by bearings in the bores of bed 21 of trough-catch 3.

Driven (upper) levers 23 (Fig.44) are installed so that their upper heads are supported by bearings in the cheeks of bracket 14, whereas the lower heads are coupled with the trough-catch bed by means of two shafts, one of them being an eccentric shaft. The other (non-eccentric) shaft is mounted inside the eccentric shaft in two ball bearings and secured at the ends by nuts.

At their upper portion the driven levers are coupled by sole plate 41 welded to them. Rubber stop 12 is attached to the sole plate top, and the round hop limiter with a slide is secured through hinges in the lower portion of the sole plate.

The operation of the lever reduction gear electric motor causes rotation of output gear 14 (Fig.47) and turning of toothed sector 9 (Fig.48) of the right-hand driving lever. Shaft 10 with gears 11 and the left-hand driving lever sector turn together with the right-hand driving lever sector. The driving levers lower ends move trough-catch 3 and the driven levers coupled with bed 21 of the trough-catch.

Trough-catch 6 (Fig.44) serves to catch the rounds from the conveyer seats and deliver them to the loading line. The trough-catch consists of trough 3 (Fig.48), bed 21, two pawls 5, a trough-catch pawls opening and closing mechanism, and levers.

The trough is a shaped concave plate riveted to the base (bed). The bed serves to mount the main components of the trough.

In the cheeks of the bed lower portion there are holes to receive the supports of the shafts of the lower ends of the feed mechanism driving and driven levers.

In the front portion of the bed there are bosses for mounting the axles of two trough-catch pawls and two stops. The pawls serve to catch and hold the round.

Mounted between the bed cheeks on the splines of the driving levers shaft is cam 17 which acts on the rod of the pawls opening and closing mechanism.

The mechanism for opening and closing mechanism trough-catch pawls 5 consists of sleeve 24, two locks (pawls opened position lock 2 and pawls closed position lock 6), two shafts 23 of the pawls, two rods 22, the rod of pawls opening spring 27 and pawls closing spring 26, a pin and fork 25. Sleeve 24 is located in the longitudinal hole of the boss of bed 21. The sleeve wall has grooves for cam 17, pin 28 and rods 22. Fork 25 is secured at the end of the sleeve. The ends of rods 22 are hinged on a pin in the sleeve slot. The other ends of the rods are coupled with shafts 23 of trough pawls 5. Cam 17 acts on the rod of the pawls opening and closing mechanism.

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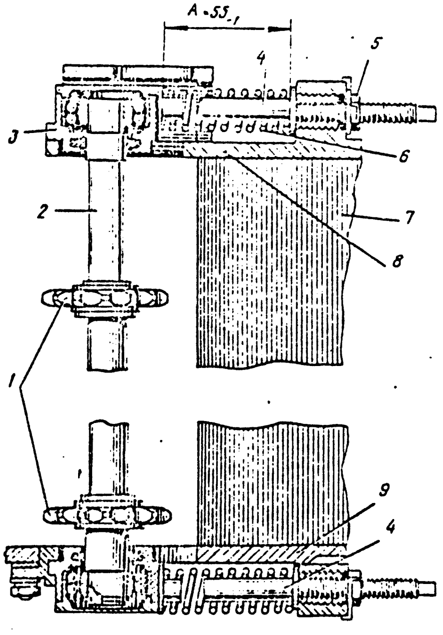

FIG.45. CONVEYER TENSIONING DEVICE

1 - driven sprockets; 2 - driven shaft; 3 - bearing body; 4 - tensioning mechanism screw; 5 - screw locknut; 6 - spring; 7 - frame; 8 - upper guide; 9 - lower guide

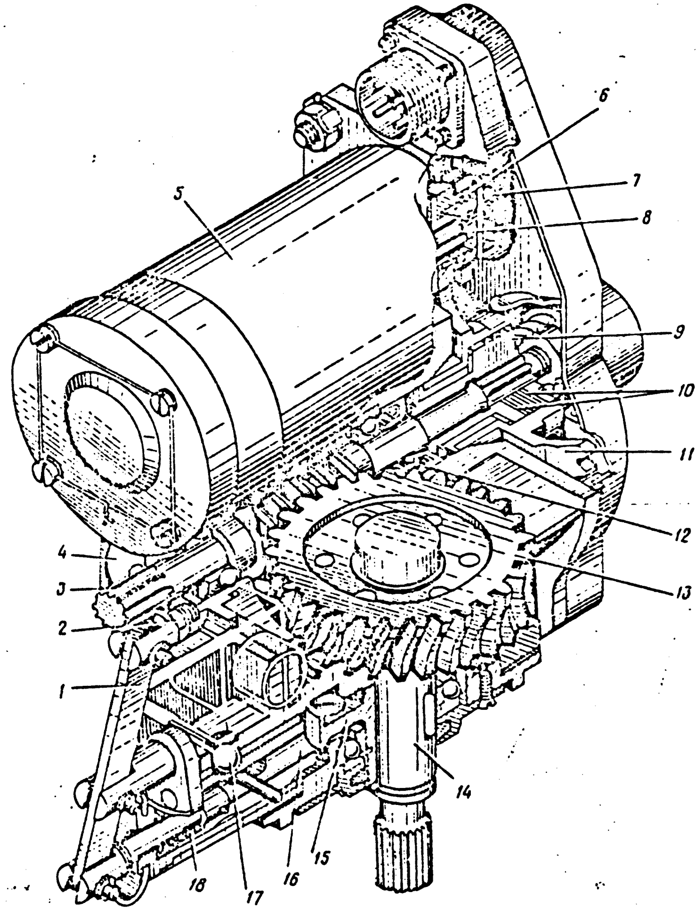

FIG.46. CONVEYER DRIVE REDUCTION GEAR

1 - retainer lever; 2 - electromagnet rod; 3 - worm; 4 - electromagnet; 5 - conveyer electric motor; 6 - driving gear; 7 - clamping cone; 8 - electric motor shaft; 9 - friction clutch pressure disc; 10 - friction clutch friction discs; 11 - driven gear; 12 - worm packing; 13 - worm wheel; 14 - conveyer drive shaft; 15 - locking disc; 16 - retainer; 17 - limit switch push ball; 18 - retainer spring

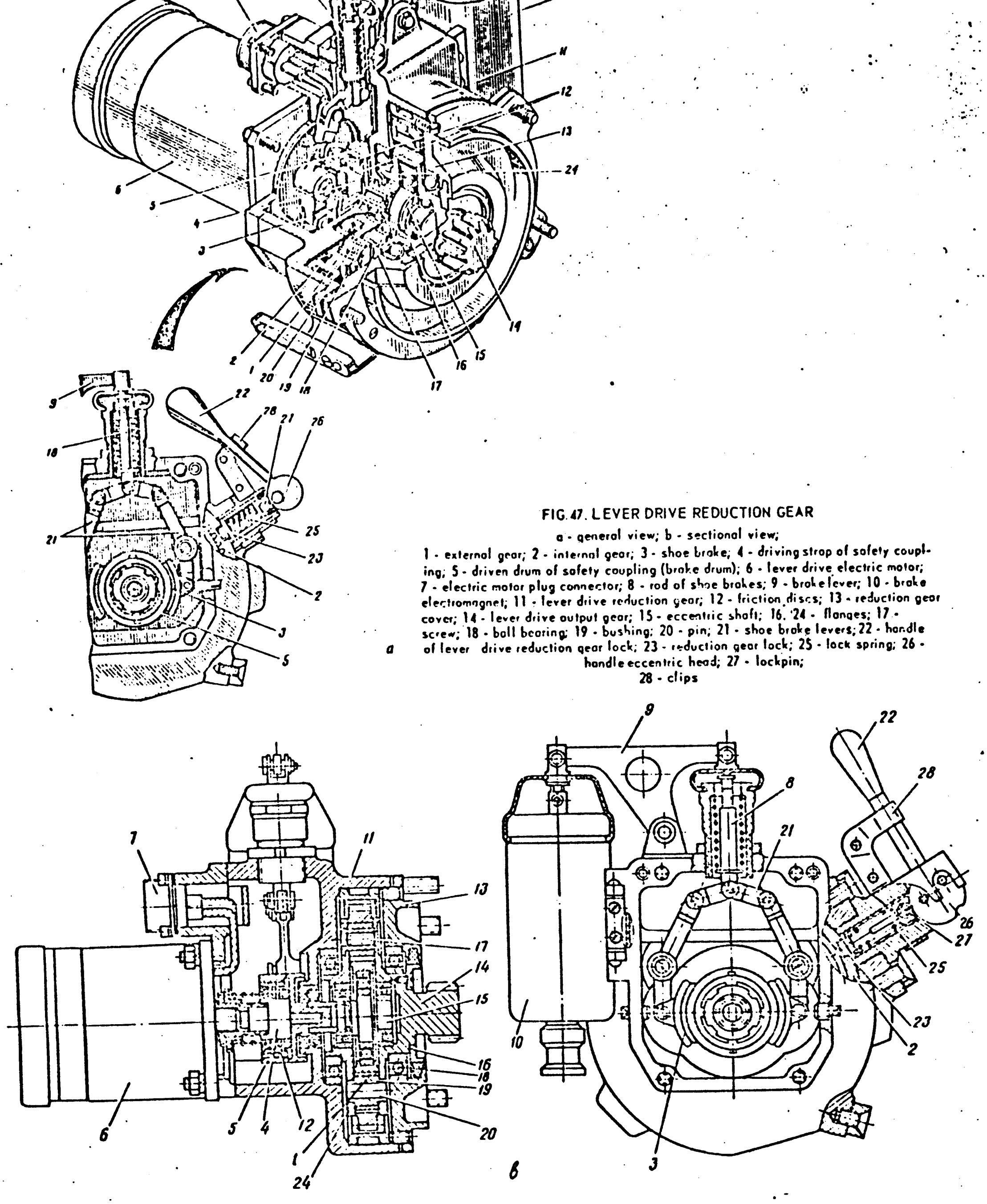
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FIG. 47. LEVER DRIVE REDUCTION GEAR

a - general view; b - sectional view;

1 - external gear; 2 - internal gear; 3 - shoe brake; 4 - driving strop of safety coupling; 5 - driven drum of safety coupling (brake drum); 6 - lever drive electric motor; 7 - electric motor plug connector; 8 - rod of shoe brakes; 9 - brake lever; 10 - brake electromagnet; 11 - lever drive reduction gear; 12 - friction discs; 13 - reduction gear cover; 14 - lever drive output gear; 15 - eccentric shaft; 16, 24 - flanges; 17 - screw; 18 - ball bearing; 19 - bushing; 20 - pin; 21 - shoe brake levers; 22 - handle of lever drive reduction gear lock; 23 - reduction gear lock; 25 - lock spring; 26 - handle eccentric head; 27 - lockpin; 28 - clips

[redacted]

ed, and two limit switches to indicate the presence of the round on the trough and functioning of the trough pawls.

The trough-catch operates as follows. At the moment a round comes to the supply line the trough-catch approaches the round and the lever roller presses wedge 4 of seat 2 thus releasing the round. At the same time as the trough-catch approaches the round, right-hand driving lever 18 (Fig.48) presses lock 2, and sleeve 24 moves forward under the action of spring 27 until it is locked by lock 6. As this takes place, the sleeve slot edge presses rods 22 that draw together pawls 5 of the trough-catch to catch the round. While moving, the sleeve releases the button of the limit switch, which stops the electric motor of the lever drive reduction gear.

Upon depression of push button K or O on the control panel, the gun assumes the position for loading, the electric motor of the lever drive gets energized and the driving levers move the trough-catch with the round to the loading line. As this takes place, the trough-catch stops come to rest on the gun carriage camplates and the rubber stop of the driven levers is pressed against the turret roof. As the trough-catch goes up cam 17 compresses spring 26 by means of pusher 16. When the trough-catch approaches the loading line, right-hand driven lever 8 presses lock 6, depresses it and sleeve 24 (moving under the action of the spring) releases the rods that put apart the trough-catch pawls to release the round.

At the end of the sleeve motion the round nut (stop 1) located on the sleeve end face is catched by lock 2, and the sleeve gets locked.

The rammer (Fig.49) serves to ram the round from the trough-catch into the barrel bore.

It consists of electric motor 1, reduction gear body 5, splined bushing 24 fitted on the electric motor shaft, a friction clutch, a carrier, driving gear 15, cluster gear 10, driven gear 8, driving roller 6, drum 17 with a gear, a stop and band 26 wound on the drum, pressure roller 27, ratchet-type safety coupling 13, a driving roller drive, and limit switch 28.

The friction clutch also serves as a safety coupling. It consists of driving discs 19 coupled through strap 25 with splined bushing 24, driven discs 18 whose lugs enter the slots of carrier 29, and spring 20 compressing the discs.

The ratchet-type safety coupling includes gear 11 with two screw chamfers on the end to receive cylindrical retainer 12 pressed by spring 14.

The friction and ratchet-type safety couplings function in case of overloads arising when ramming the round or removing the band.

Rammer band 26 has the shape of a trough, which gives it the required rigidity. In the initial position the band is wound on drum 17.

Limit switch 28 consists of pusher 30 pressed by spring 31, ball 31 and a microbutton.

The rammer operates as follows. Rotation of the shaft of electric motor 1 is transmitted through bushing 24 and strap 25 to the clutch, and then from the clutch to carrier 29 and driving gear 15. Rotation of the smaller gear of cluster gear 10 causes rotation of driven gear 8 fitted on shaft 3 of driving roller 6.

As driving roller 6 rotates, band 26 clamped between the driving roller and pressure roller 27 moves forward under the action of the frictional force and the rotating drum, and rams the round. Pressure roller 27 fitted on the axle of lever 34 is continuously pressed against the band from below by spring 35.

After the band moves forward, pusher 30 moves under the action of spring 31, presses down ball 32 and pushes microbutton 33 to stop the rammer electric motor.

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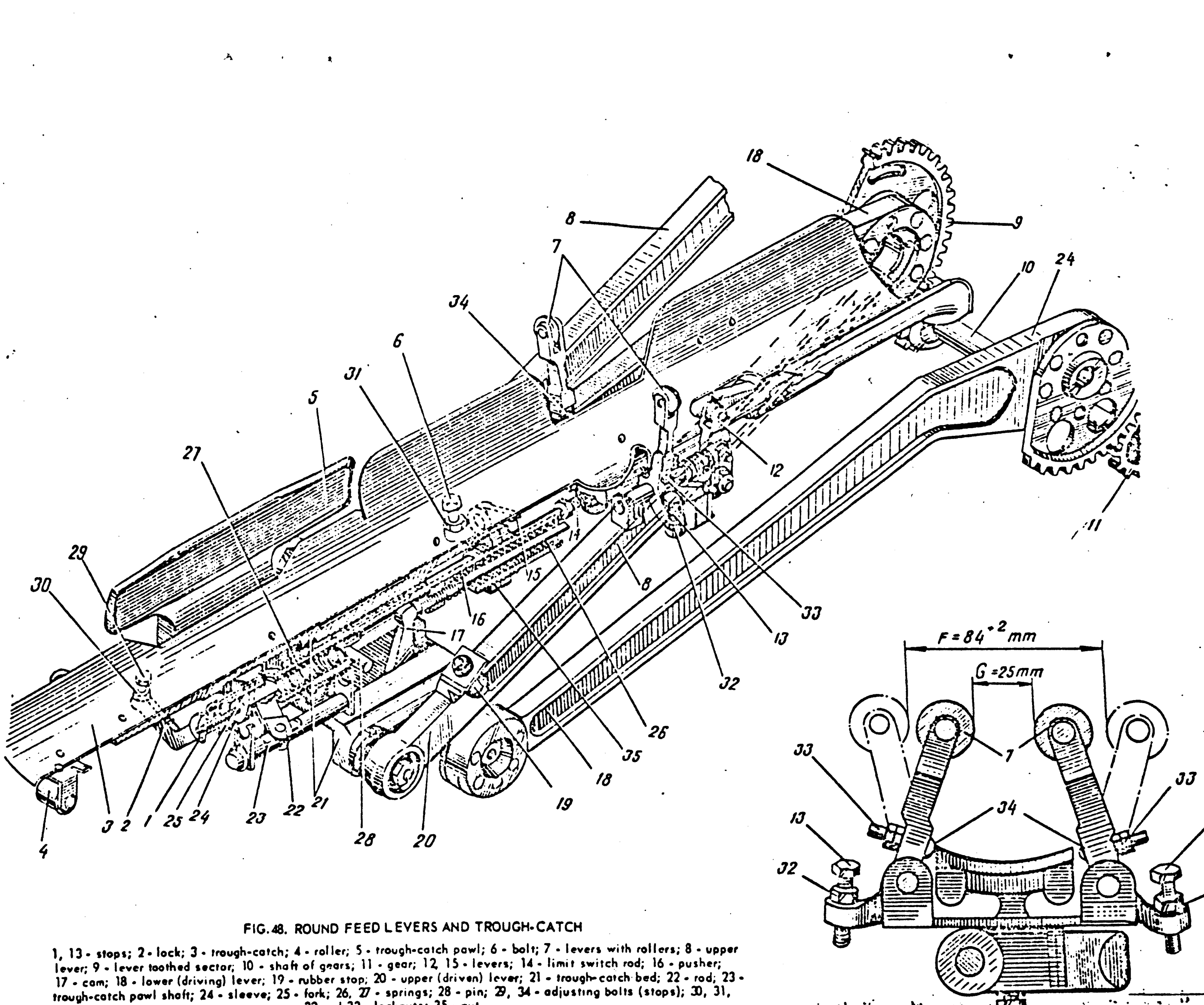
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F=84+2 mm
G=25mm
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33

FIG.48. ROUND FEED LEVERS AND TROUGH-CATCH

1, 13 - stops; 2 - lock; 3 - trough-catch; 4 - roller; 5 - trough-catch pawl; 6 - bolt; 7 - levers with rollers; 8 - upper lever; 9 - lever toothed sector; 10 - shaft of gears; 11 - gear; 12, 15 - levers; 14 - limit switch rod; 16 - pusher; 17 - cam; 18 - lower (driving) lever; 19 - rubber stop; 20 - upper (driven) lever; 21 - trough-catch bed; 22 - rod; 23 - trough-catch pawl shaft; 24 - sleeve; 25 - fork; 26, 27 - springs; 28 - pin; 29, 34 - adjusting bolts (stops); 30, 31, 32 and 33 - locknuts; 35 - nut

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At the end of the reverse motion, buffer 38 of band 26 presses stop 39 and moves pusher 30. The pusher releases microbutton 33 by ball 32 and stops the electric motor.

As this occurs, the drum slot disengages the tooth of stop 36, thus unlocking the drum.

To return the rammer band in case of electric drive failure, it is necessary to install the handle from the SPTA set on the splined end of shaft 3, and turn the shaft by hand.

Operation of Loading Mechanism

Prior to operating the loading mechanism it is necessary to do the following:

- install the operator's seat guard;
- unlock the turret;
- manually open the gun breechblock;
- switch the turret traversing mechanism and the gun elevating mechanism for operation from the electric drive;
- turn on switches LM (МЗ) and DRIVE (ПРИВОД) on the turret board and the laying drive control panel.

When the loading mechanism levers are lowered and the round is catched by the trough-catch pawls, the loading mechanism parts operate as follows:

(a) upon depression of push button K or O on the control panel the gun is set at the loading angle;

(b) the feed mechanism moves the trough-catch to the loading line;

(c) as the trough-catch arrives at the loading line, the motors of the rammer and conveyer drive are started;

(d) the rammer band rams the round into the barrel bore; the breechblock wedge gets closed and the rammer electric motor is switched for reverse motion;

(e) the lever drive electric motor is switched on at the end of the rammer band motion;

(f) the trough-catch moves down for the next loading;

(g) as the levers with the trough-catch move down, the conveyer turns and delivers the next round to the supply line;

(h) as the trough-catch approaches the round, it releases the round from the seat and catches it with the pawls.

When there is no round in the next seat the loading mechanism functions in the following way.

If the conveyer seats are empty and the round does not press limit switch ROUND PRESENT (НАЛИЧИЕ ВЫСТРЕЛА), the levers with the trough-catch are stopped in the intermediate position by means of the limit switch installed on the lever drive reduction gear. The push button of this limit switch is pressed by the camplate secured on the toothed sector of the right-hand driving lever and the lever drive electric motor gets deenergized.

When the next round arrives at the supply line, it presses the limit switch, switches on the electric motor of the lever drive, and the trough-catch moves down to the round.

When the conveyer operates in the rewinding mode the loading mechanism functions as follows.

If it happens necessary to move the conveyer without loading it (i.e. when filling it with rounds, during inspections, etc.) it is necessary to press button CONVEYER (КОНВЕЙЕР) on the turret board. In this case the feed mechanism levers move up (if they were in the lower position) and disconnect the limit switch of the lever drive reduction gear in the intermediate position, as a result of which the levers stop.

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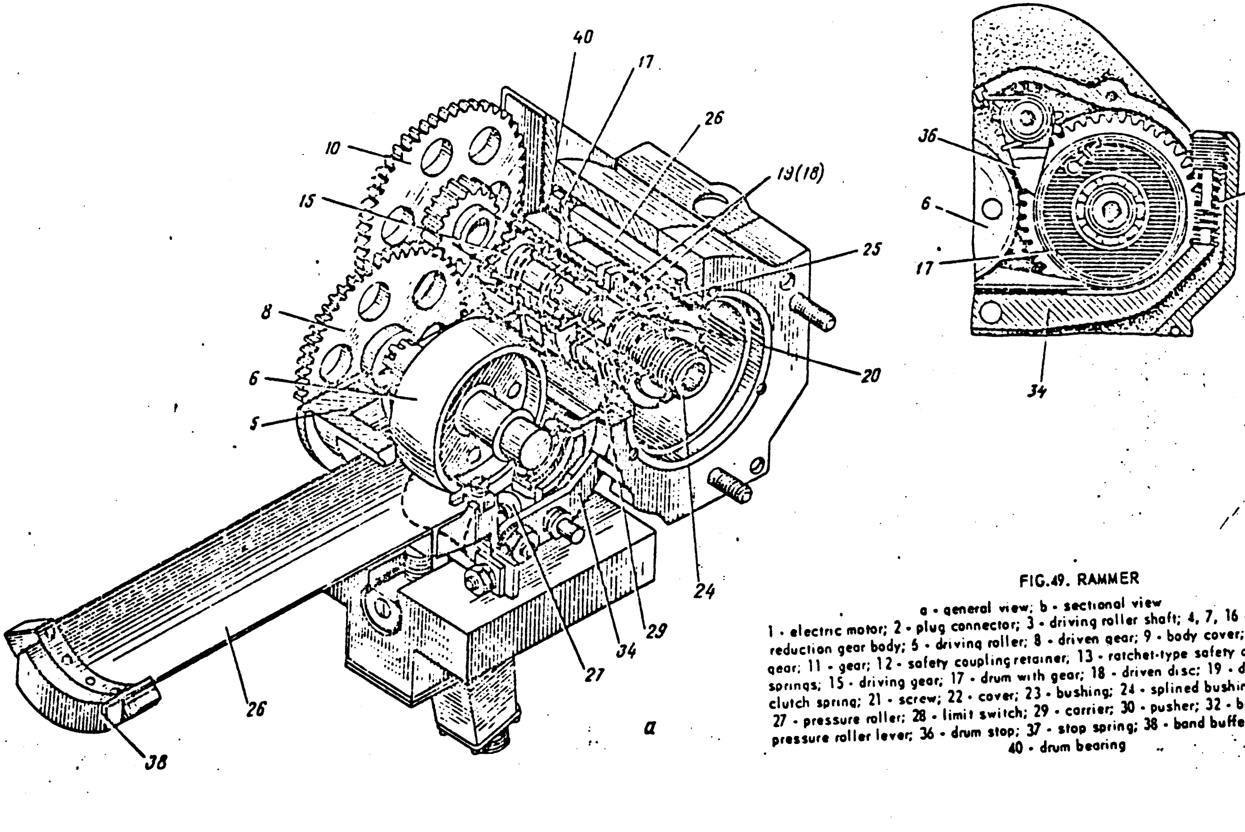

FIG.49. RAMMER

a - general view; b - sectional view
1 - electric motor; 2 - plug connector; 3 - driving roller shaft; 4, 7, 16 - ball bearings; 5
reduction gear body; 5 - driving roller; 8 - driven gear; 9 - body cover; 10 - intermediate
gear; 11 - gear; 12 - safety coupling retainer; 13 - ratchet-type safety coupling; 14, 31,
springs; 15 - driving gear; 17 - drum with gear; 18 - driven disc; 19 - driving disc; 20 - f
clutch spring; 21 - screw; 22 - cover; 23 - bushing; 24 - splined bushing; 25 - strap; 26 -
27 - pressure roller; 28 - limit switch; 29 - carrier; 30 - pusher; 32 - ball; 33 - microbutt
pressure roller lever; 36 - drum stop; 37 - stop spring; 38 - band buffer; 39 - limit switc
40 - drum bearing

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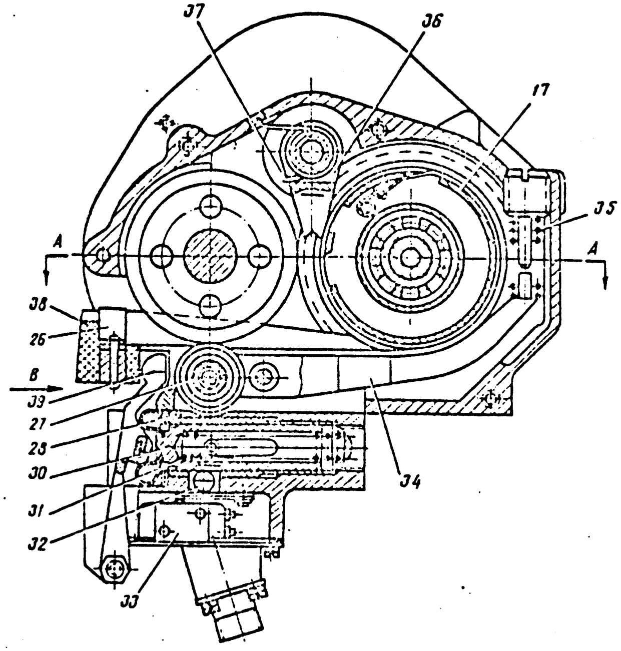
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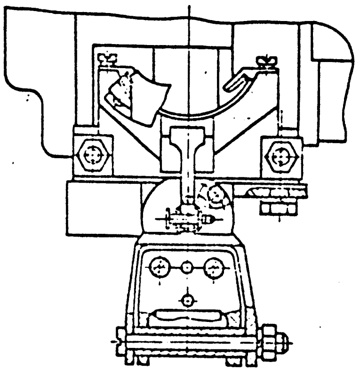
View B



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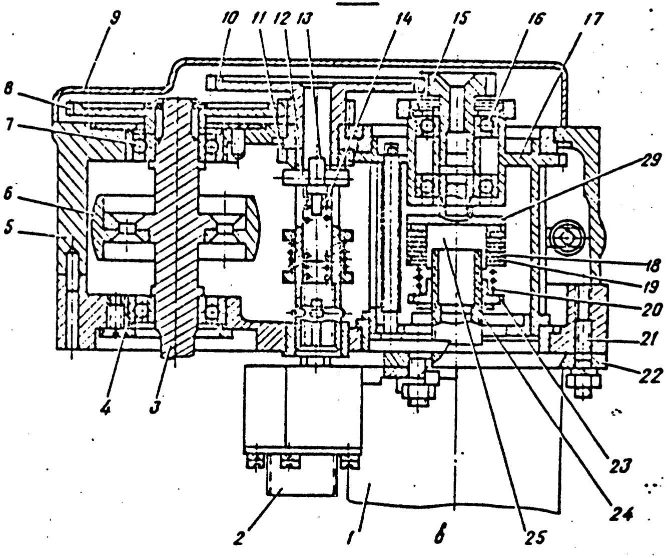
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as follows.

If before the loading the trough-catch is in an intermediate position, to perform the loading it is necessary to carry out all the preparatory operations listed above. In this case the following operations will take place:

(a) if the trough-catch pawls are closed with no round present, the trough-catch moves up, its pawls get open, then the trough-catch moves down and catches the round starting thereby the loading cycle as described above;

(b) if the trough-catch pawls hold the round, the trough moves up, its pawls open and the round is rammed into the breech chamber; then the trough-catch moves down and its pawls catch the next round;

(c) if the trough-catch pawls stay apart, the trough moves down, catches the round and the normal loading cycle begins.

Operation of Round Feed Mechanism Levers by Hand

If it is required to set the levers to the appropriate position without actuating the electric drive, proceed as follows:

- unlock the lever drive reduction gear by turning down lock handle 22 (Fig.47);
- move the levers to the required position by hand;
- lock the levers by turning up handle 22 and securing it in clips 28.

Electrical Equipment of Loading Mechanism

The loading mechanism electrical equipment (Fig.50) comprises the following units:

(a) electric motors of the lever drive (M2), conveyer drive (M1), rammer drive (M3);

(b) electromagnets of the gun lock (ЭМ3), conveyer lock (ЭМ2), gun lock latch (ЭМ1), lever drive reduction gear brake (ЭМ4);

(c) limit switches of the gun lock ($K_{\text{сст}}$), lever drive reduction gear ($K_{\text{рм}}$), trough-catch pawls (Kзх), round presence on the trough (Kнл), round presence in the conveyer (Kнн), conveyer pitch (Kшк), rammer (Kд);

(d) contacts of breechblock wedge open position (Kко) and breechblock wedge closed position (Kкз);

(e) safety devices, including automatic circuit breaker A3P50 (M3) and a fuse (Пр);

(f) switch buttons of the conveyer (K) and levers (O);

(g) relays of wedge position (P1a and P1b), rammer position (P2a and P2b), round presence on the trough (P3a and P3b), cycle continuation (P4a and P4b), cycle starting (P5a and P5b);

(h) contactors of conveyer reversing (P10), gun lock latch electromagnet (P13), conveyer drive electric motor (P14), rammer band return (P15), lever drive electric motor (P16 and P18), rammer electric motor (P17).

Besides, the electrical equipment includes control unit БУ-40, switch LM, signal lamps Л1 (green) and Л2 (red), electric wiring and fittings.

In the loading mode the loading mechanism electrical equipment functions as follows.

When the loading mechanism is in the initial position (the trough-catch is lowered and its pawls clamp the round) limit switches $K_{\text{рм}}$, Kнн and Kнл are closed (pressed).

To load the gun, it is necessary first to prepare laying electric drive 13Ц10М for operation and then turn on switches B1 (LM) on the turret board and B2 (LM) on the control panel, and open the breechblock wedge. Then press button Кн1 or Кн2 (K or O) on the control panel.

When switch B2 is turned on, red signal lamp Л2 arranged at the left on the turret roof should light up. Current passing through normally-closed contacts 1-2 (Fig.50) of trough-

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Upon depression of button Кн1 (К) or Кн2 (О) voltage is fed to the windings of cycle-start relays P5a and P5b and through diode Д2 to cycle-continuation relays P4a and P4b. The above relays operate and close their contacts 3-5. With button Кн1 or Кн2 released, current continues to pass to the relay windings coils through contacts 3-5 of relay P5 over the circuit of wedge closed position contact K_{KO} and diodes Д3 and Д2.

From the windings of the above relays current comes to the windings of setting relay P6a, firing circuit relay P6b and the gun lock latch contactor relay to energize the relays.

During loading cycle, relay P4c breaks the rammer band tensioning circuit. Normally-closed contacts 3-4 of relay P6b break, and open the firing circuit.

The contacts of relay P6a switch the elevating drive from the control panel to the setting device, and the gun goes to the position for loading.

Contacts 3-5 of relay P6c close and apply voltage through contacts 1-2 of limit switch K_{3X}, contacts 1-2 of limit switch K_{CCT} to the winding of relay P13. The contacts 2, 5-3 and 6 of relay P13 close and apply voltage to the winding of gun lock latch electromagnet ЭМ1. Under the action of the spring the lock gets free and locks the gun at the loading angle.

The lock presses the rod of limit switch K_{CCT} which opens normally-closed contacts 1-2 and deenergizes the windings of relay P13. As a result, contacts 2, 5-3 and 5 of relay P13 break, thus deenergizing the windings of electromagnet ЭМ1 and releasing the latch.

Besides, the lock closes normally-open contacts 3-4 of limit switch K_{CCT}, and voltage is fed through the circuit of contacts K_{KO}, contacts 5-3 of relay P5a, contacts 3-5 of relay P5b, contacts 3-4 of relay P1b, contacts 3-4 of limit switch K_{CCT} and contacts 3-5 of relay P8 to the winding of contactor P18 (A-B).

As a result, contacts 1-2 of contactor P18 close and voltage is applied to the winding of electromotor M2 of the lever drive and through contacts 1-2 of relay P-12 to brake electromagnet ЭМ4. The lever drive reduction gear gets released. Electromotor M2 raises the levers with trough-catch and round onto the loading line.

As the levers rise, the rods of limit switches K_{PM} and K_{HH} are released, their contacts 3-4 open and contacts 1-2 close.

At the loading line normally closed contacts 1-3 of limit switch K_{3X} open and the winding of relay P8 gets deenergized. Contacts 3-5 of relay P8 open, while contacts 3-4 close and deenergize the winding of contactor P18. As a result, contacts 1-2 of the contactor open and deenergize motor M-2 and electromagnet ЭМ4. The feed mechanism levers are braked and contactor P17 of the rammer motor is prepared for functioning.

Contacts 3-4 of limit switch K_{3X} close and voltage is additionally supplied through contacts 5-3 of relay P4a and diode Д1 to the windings of relays P4a and P4b. Voltage is fed through contacts 3-5 of relay P4b and contacts 1-2 of limit switch K_{HH} to the winding of relay P11. The relay operates and closes contacts 5-6 of relay P11. Through these contacts voltage is supplied to the winding of electromagnet ЭМ2 which frees the conveyer.

If the force of electromagnet ЭМ2 is insufficient, then upon closure of contacts 2-3 of relay P11 voltage is also applied to the winding of conveyer reversing contactor P10, which closes its contacts 2-1 and reverses electric motor M-1 of the conveyer drive, thus aiding electromagnet ЭМ2 in unlocking the conveyer.

As soon as the conveyer gets released, conveyer pitch limit switch $K_{ШK}$ functions to break contacts 1-2 and close contacts 3-4. As contacts 3-4 of limit switch $K_{ШK}$ close, voltage is applied to the windings of contactor P14 and conveyer reversing relay P7. Relay P7 opens its contacts 1-2, thereby deenergizing contactor P10 and electric motor M1, which stops the conveyer reversing.

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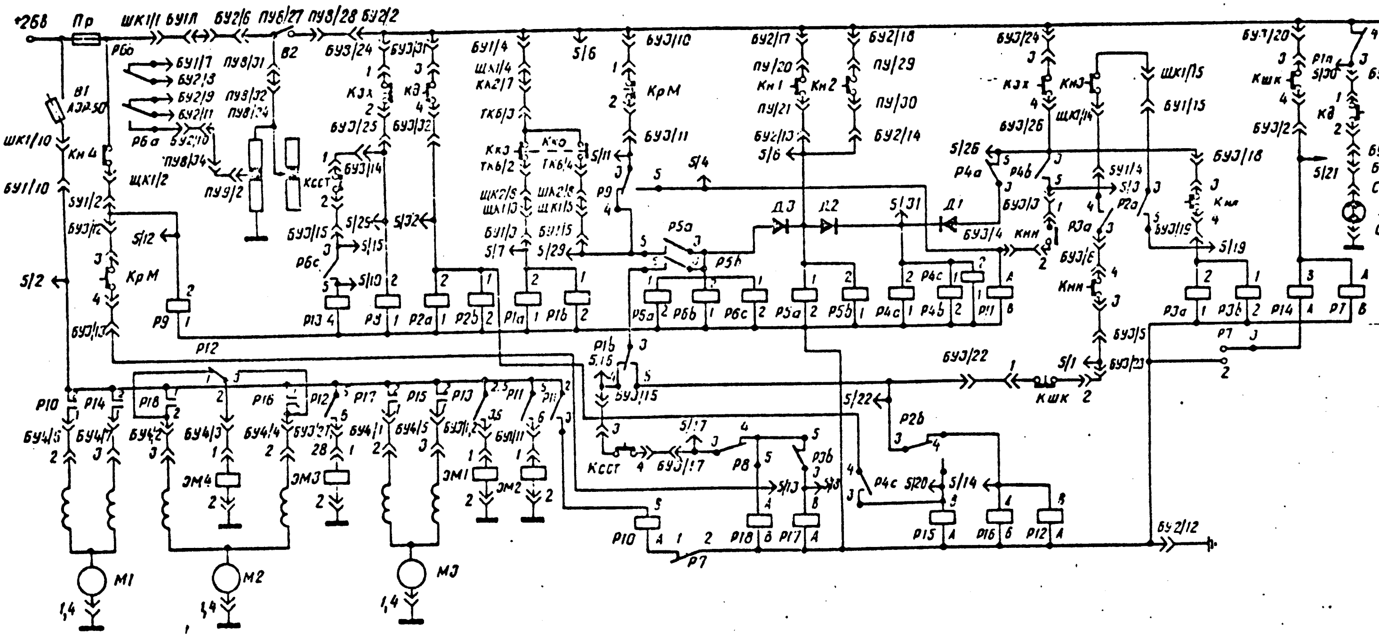
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Кзх
Кд
Кн1
Кн2
Кн3
Кнн
Кшк
Ксст
Кш
Д1
Д2
Д3
Р1а
Р1б
Р2а
Р2б
Р3а
Р3б
Р4а
Р4б
Р4с
Р5а
Р5б
Р6б
Р6с
Р7
Р8
Р9
Р10
Р11
Р12
Р13
Р14
Р15
Р16
Р17
Р18
ЭМ1
ЭМ2
ЭМ3
ЭМ4
М1
М2
М3
БУ2/12

FIG.50. DIAGRAM OF LOADING MECHANISM ELECTRICAL EQUIPMENT

Л1 - green signal lamp of loading mechanism readiness; Л2 - red signal lamp of loading mechanism engagement; Кн1, Кн2 - buttons (K or O); Кн3 - lever lowering button LEVERS (РЫЧАГИ); Кн4 - conveyer start button CONVEYER (КОНВЕЙЕР); Пр - fuse; B1 - loading mechanism switch on turret board; B2 - loading mechanism switch on control panel; $K_{ШК}$ - conveyer pitch limit switch; $K_{ССТ}$ - gun lock limit switch; $K_{РМ}$ - lever drive reduction gear limit switch; $K_{НЛ}$ - limit switch of round presence on trough; $K_{НН}$ - limit switch of round presence in conveyer; $K_{ЗХ}$ - limit switch of trough-catch pawls; $K_{Д}$ - rammer limit switch; $K_{КО}$ - limit switch of open breechblock wedge contacts; $K_{КЗ}$ - limit switch of closed breechblock wedge contacts; P1a, P1b - breechblock wedge position relays; P2a, P2b - rammer position relays; P3a, P3b - relays of round presence on trough; P4a, P4b - relays of cycle continuation; P5a ; P5b - relays of cycle starting; P6a, -cycle relay; P6b - relay of firing circuits; P6c - relay of gun lock latch contactor; P7 - relay of conveyer drive electric motor reversing; P8 - relay of trough-catch pawls; P9 - relay of conveyer rewinding; P4c - relay of band pull; P11 - relay of conveyer retainer electromagnet; P12 - relay of gun lock electromagnet; P10 - contactor of conveyer reversing; P13 - contactor of gun lock latch; P14 - contactor of conveyer electric motor; P15 - contactor of rammer band return; P16, P18 - contactors of lever drive reduction gear electric motor; P17 - contactor of rammer electric motor; ЭM1 - electromagnet of gun lock latch; ЭM2 - electromagnet of conveyer retainer; ЭM3 - electromagnet of gun lock; ЭM4 - electromagnet of lever drive reduction gear brake; M1 - conveyer drive electric motor; M2 - lever drive electric motor; M3 - rammer electric motor lowering circuit. Relay P3b opens its contacts 5-3 and actuates contactor P17. Contacts 2-1 of contactor P17 close and energize electric motor M3 of the rammer. The round is rammed into the breech chamber.

At the beginning of its motion the rammer band presses limit switch $K_{Д}$. Contacts 1-2 of limit switch $K_{Д}$ break the circuit of signal lamp Л1 and the lamp goes out. At the same time, contacts 3-4 close and voltage is supplied to the windings of rammer relays P2a and P2b.

The relays operate, and contacts 3-4 of relay P2a lock limit switch $K_{НЛ}$ whose contacts 3-4 break as the round clears the trough-catch, while contacts 3-5 of relay P2b prepare contactor P15 for operation.

When the breechblock wedge gets closed, contacts $K_{КО}$ open and contacts $K_{КЗ}$ close. After contacts $K_{КО}$ get broken, relays P6a, P6b, P6c, p5a and P5b remain energized along the circuit of contacts 1-2 of limit switch $K_{РМ}$, contacts 3-4 of relay P9 and contacts 5-3 of relay P5a.

As contacts $K_{КЗ}$ close, voltage is fed to the windings of relays P1a and P1b. Contacts 4-3 of relay P1a break and open the circuit of signal lamp Л1. Contacts 3-4 of relay P1b break and cut off contactor P17, thereby deenergizing electric motor M3. The rammer band stops in the forward position.

As contacts 3-5 of relay P1b close, contactor P15 operates, its contacts energize electric motor M3 for reverse rotation, and the rammer band returns to the initial position.

At the end of its return the band presses limit switch $K_{Д}$ and contacts 1-2 close. Closing of these contacts prepares lamp Л1 for lighting up. Breaking of contacts 3-4 deenergizes relays P2a and P2b.

Opening of contacts 3-5 of relay P2a cuts off relays P3a and P3b. Contacts 3-4 of relay P3a close and prepare the feed mechanism levers circuit, while contacts 3-5 of relay P3b (included in the circuit of the winding of contactor P17) break.

At the same time, contacts 3-4 of relay P2b break and deenergize electric motor M3.

As relay P2b operates, voltage is fed through contacts 1-2 of limit switch $K_{РМ}$, contacts 3-4 of relay P9, contacts 5-3 of relay P5a, contacts 3-5 of relay P5b, contacts 3-5 of relay P1b and contacts 3-4 of relay P2b to the windings of relay P12 and contactor P16. The above relays and the contactor get energized. The contacts of relay P12 close and apply voltage to electromagnet ЭМ3. The gun gets disengaged from the lock, and contacts 1-2 of limit switch $K_{ССТ}$ close. Energized contactor P16 closes its contacts 1-2 and applies voltage to electric motor M2 and through contacts 3-2 of relay P12 to electromagnet ЭМ4.

As this takes place, electromagnet ЭМ4 unbrakes the lever drive reduction gear and the electric motor lowers the levers together with the trough-catch. As the levers approach the intermediate position, contacts 1-2 of limit switch $K_{РМ}$ break and relays P6a, P6b, P6c, P5a, P5b and P12 and contactor P16 get deenergized.

When relay P12 and contactor P16 get deenergized, electromagnets ЭМ3 and ЭМ4 and electric motor M2 get deenergized too, as a result of which the levers with the trough-catch stop and get locked in the intermediate position. This occurs, however, only in the case when the interval between the previous and next rounds is equal to four or more seats.

In other cases the next round approaching the supply line to a distance of 40 to 50 mm has time to press limit switch $K_{НН}$ before the levers with the trough-catch stop in the intermediate position, thus ensuring their lowering to the initial position without delay.

This happens due to the fact that when limit switch $K_{НН}$ is pressed its contacts 1-2 break and contacts 3-4 close, and breaking of contacts 1-2 deenergizes contactor P-11 and electromagnet ЭМ2.

[redacted]

of relay P3a, contacts 4-3 of limit switch K_{HH}, contacts 2-1 of limit switch $K_{шк}$ and contacts 3-4 of relay P2b to the windings of relay P12 and contactor P16. The latter get energized anew and supply voltage to electromagnets 3M3 and 3M4 and electric motor M2 which lowers the levers with the trough-catch to the initial position. As this occurs, limit switch K_{3x} gets released and its contacts 3-4 break to cut off relays P4a, P4b and P12 and contactor P16. Electric motor M2 gets deenergized and stops, while the lever drive reduction gear is braked.

When relay P6a is deenergized its contacts 3-4 close and switch the elevating drive from the setting device to the control panel. When relay P6b is cut off, its contacts 3-4 close and restore the firing circuit. When relay P6c is cut off its contacts 3-5 open and deenergize the windings of contactor P13.

At this stage the loading cycle is completed and the gun can be fired.

To load the gun with the next round, it is necessary to press button K or O.

When rounds are loaded into or removed from the conveyer the loading mechanism electrical equipment functions as follows.

To move the conveyer without loading, turn on switch B1 (LM) and press button Kн4 (CONVEYER) on the turret board.

When button CONVEYER is pressed voltage is applied to the winding of relay P9 and through closed contacts 3-4 of limit switch $K_{pм}$ to the winding of contactor P18. In this case the contacts of relay P9 switch from position 3-4 to position 4-5, and contacts 1-2 of contactor P18 get closed. Voltage is supplied through closed contacts 1-2 to electromagnet ЭМ4 and electric motor M2. As a result, the lever drive reduction gear is unbraked and the levers go up until the camplate of the sector opens contacts 3-4 and closes contacts 1-2 of limit switch $K_{pм}$. Opening of contacts 3-4 causes the levers to stop, whereas closing of contacts 1-2 ensure voltage supply to the winding of contactor P11 and the conveyer starts moving until the CONVEYER button is depressed.

When the levers are lowered the loading mechanism electrical equipment functions as follows.

To lower the levers to their initial position, turn on switches B1 and B2 and press button Kн3 (LEVERS) on the turret board.

As this takes place, the trough-catch pawls should be open (limit switch K_{3x} should be pressed).

When button Kн3 is pressed voltage is supplied through closed contacts 3-4 of limit switch K_{3x} and contacts 1-2 of limit switch K_{HH} to the winding of relay P11 (in case there is no round in the initial position). The conveyer starts to move and carries the round to the supply line where the round presses limit switch K_{HH} thus stopping the conveyer. Contacts 3-4 of limit switch Kн3 close and voltage is supplied through button Kн3, contacts 4-3 of relay P3a, contacts 4-3 of limit switch K_{HH}, contacts 1-2 of limit switch $K_{дк}$ and contacts 3-4 of relay P2b to contactor P16, and then through its closed contacts 3-4 to electric motor M2 and electromagnet ЭМ4. As a result, the levers move down, the trough-catch pawls catch the round and break contacts 3-4 of limit switch K_{3x}. Electric motor M2 and electromagnet ЭМ4 get deenergized, so button Kн3 may be released.

3.2.5. Care of Gun

The care of the gun includes the following operations:

- cleaning the gun after firing and checking its condition;
- checking the functioning of the manual reloading mechanism, separator, rebound lock mechanism, electric firing pin circuit and loading mechanism;

[redacted]

Immediately after firing lubricate the bore with lubricant ГОИ-54п (GOST 3276-63). Clean the bore with the use of tow wetted with hot water and wound around the cleaning rod brush. In winter, use diesel fuel instead of hot water. Insert the cleaning rod into the bore from the muzzle and clean the bore several times. After cleaning wipe the bore with clean tow and then with waste wound around the brush. If the waste shows traces of fouling, rust or dirt, continue to clean the bore until th wiping waste is clean.

To perform partial disassembly of the gun, proceed as follows:

(a) turn off switches LM, TRIGGERS (СПУСКИ) and DRIVE (ПРИВОД) on the turret board and control panel;

(b) close the breechblock;

(c) detach the breechblock from the breech ring, for which purpose:

- press in turn handles 6 (Fig.37) of the closing mechanism and turn them either side through 90°;
- withdraw the guide bushings from the socket of breech ring cover 11 (Fig.33) and remove springs 15 by moving them down;
- remove cover 11 from the breech ring by moving it horizontally to the barrel muzzle face;
- detach the breechblock from the breech ring by lowering it with the help of the lever with a grip;

(d) detach the firing pin from the breechblock, for which purpose:

- unscrew nut 17 (Fig.36) from the firing pin hole;
- remove insulating washer 18, contacts 21 and 19 with the spring and insulating bushing 22. Withdraw bushing 22 by means of a pin wrench fitted into the bushing hole;
- detach sleeve assembly 23 and firing pin 26;

(e) detach breechblock body-to-cartridge case contact 29, for which purpose:

- remove cover 27 from the slots of the breechblock rear wall;
- remove plunger 28, the spring and contact 29.

Clean the barrel external surface with waste. Pay special attention to the cleanness of the breech recess slots, hard-to-reach depressions and sharp corners. While cleaning, see that the parts of the mechanisms are not damaged.

Eliminate the detected nicks, dents and other faults on the guide camplates of the breech ring and diamond-shaped lugs of the breechblock. Replace the defective parts.

Lubricate the barrel bore with waste soaked in lubricant ГОИ-54п and wound around the cleaning rod brush. Move the brush smoothly and see that the layer of lubricant is thin and uniform.

Remove fouling from the breechblock with waste soaked in hot water (in winter, in diesel fuel). Wipe the breechblock dry and coat it with a thin layer of lubricant ГОИ-54п by means of a brush fitted on a holder.

Clean the breechblock parts, wash them in gasoline and wipe dry.

Wipe all non-painted surfaces, as well as the areas having a damaged paint coating, with waste soaked in lubricant ГОИ-54п.

Assemble the breechblock mechanisms and install the breechblock. To assemble, reverse the disassembly procedure.

Check the electric firing pin, firing pin contact, contacts of transmitter 13 and contact of breechblock 29 for proper assembly.

[redacted]

(ЗАТВОР В НИЖНЕМ ПОЛОЖЕНИИ) should light up on the panel. When the extractor arms are pressed the breechblock must energetically move up and bear up against the breech ring insert. Lamp BREECHBLOCK IN UPPER POSITION (ЗАТВОР В ВЕРХНЕМ ПОЛОЖЕНИИ) should light up.

When the separator is pushed through an angle of 120 to 150°, it should energetically return to the initial position.

When checking the rebound lock mechanism see that while slightly striking the hammer handle against the cylindrical slot of the breechblock, the latter should be reliably retained by the rebound lock and its downward should not exceed 2 mm.

To check the electric firing pin circuit, connect one contact of the signal lamp (which is available in the SPTA set) to firing pin pusher 25 and the other contact to the body. If the circuit has no faults, the lamp should light up when button FIRE (ОГОНЬ) is pressed on the panel.

When checking the loading mechanism pay attention to the adjustment of the conveyer chain tension. To this end, check the length of the tensioning device spring (size A in Fig.45). The size should be 55_{-1} mm. Otherwise, adjust the tension, for which purpose:

(a) undo screw locknut 5;

(b) set size A by driving in screw 4;

(c) tighten up locknut 5.

To check and adjust the trough-catch pawls for proper opening and closure, proceed as follows:

(a) close the switch of the storage batteries and switches LM and DRIVE on the control panel;

(b) set the barrel at an angle of depression and release gun lock 1 (Fig.43) by pressing latch 3 (Fig.43);

(c) open the breechblock and press button K or O;

(d) set the gun at the loading angle;

(e) turn off switches LM and DRIVE;

(f) install the quadrant on the gun and operate the elevating mechanism by hand to depress the gun by the quadrant to an angle of 6 to 8' (as to the quadrant);

(g) disconnect plug connector 2 (Fig.49) of the rammer electric motor;

(h) undo the locknut of adjusting bolt 29 (Fig.48) and drive in the bolt as far as it will go;

(i) turn on switches LM on the turret board and control panel;

(j) press button K or O, and when the levers are in the upper position turn off switches LM;

(k) check size F between the rollers in the open position; prior to checking unscrew bolt 29 until the trough-catch pawls open and lock it in this position with locknut 30; size F between the rollers should be equal to 84^{+2} mm, otherwise adjustment it, for which purpose undo locknuts 32 and rottate stops 13;

(l) check size G between the rollers, for which purpose use handle 22 (Fig.47) to release the lever drive reduction gear lock, lower the levers to the intermediate position and lock them with handle 22; size G should be equal to 25 mm, otherwise undo locknuts 33 (Fig.48) and set the necessary size by turning bolts 34;

(m) check the adjustment of the trough-catch pawls, for which purpose proceed as follows:

- place a dummy round in the conveyer seat on the supply line;
- undo locknut 31 of adjusting bolt 6 and screw in the bolt as far as it will go;

[redacted]

[redacted]

To adjust the conveyer, proceed as follows:

(a) use the handle to unlock the lever drive reduction gear, and raise the levers with the trough-catch by hand;

(b) fit the handle of the conveyer manual drive on the tail piece of shaft of worm 3 (Fig.46) and rotate it in the direction shown by the arrow marked on the reduction gear cover until the reduction gear is locked;

(c) disconnect shaft 28 (Fig.44) of the conveyer drive from the driving shaft;

(d) turn shaft 28 to position the conveyer seat with the round so that the trough-catch (when it moves down) can properly catch the round and lever 12 (Fig.48) depresses wedge 4 (Fig.44) which opens thumbpiece 3 of the conveyer seat; the roller of lever 12 (Fig.48) must be on the wedge;

(e) in this position, reinstall shaft 28 (Fig.44) and connect it with the conveyer driving shaft; in case the splines of the shafts are not aligned, disconnect shaft 28 from sprocket driving shaft 35 and turn it to align the splines of shaft 28 with the splines of the conveyer driving shaft without moving the conveyer;

(f) check the conveyer for proper adjustment, for which purpose proceed as follows:

- place the dummy round (or round) in the third or fourth seat from the supply line;
- raise the feed mechanism levers to the intermediate position;
- turn on switches "LM" on the turret board and control panel;
- press button LOWERING OF LEVERS on the turret board. The conveyer starts moving. As the seat with the round arrives at the supply line, the levers should move down and the trough-catch pawls should catch the round. In this position the lever roller should be on the wedge.

To clean the rammer band, proceed as follows:

(a) open the breechblock;

(b) turn on switch LM on the turret board and switches LM and DRIVE on the control panel;

(c) press button K or O in order to raise the levers with the trough and actuate the rammer;

(d) at the end of ramming turn off switch LM on the control panel (it is forbidden to draw the band by hand);

(e) turn off switch LM on the turret board;

(f) wipe the band dry with clean waste;

(g) turn on switches LM on the turret board and control panel;

(h) press button K or O on the control panel to return the band into the rammer;

(i) turn off switch LM on the turret board and switches LM and DRIVE on the control panel;

(j) open the breechblock, remove the dummy round from the chamber and close the breechblock;

(k) turn on switches LM on the turret board and control panel and lower the levers to the initial position;

(l) turn off switches LM.

Checking of Angle Transmission

Check the accuracy of angles transmission from the gun to the sight proceed as follows:

(a) install the vehicle on a level ground;

(b) glue the bore-sight strings to the barrel muzzle face at the notches;

(c) open the breechblock and insert the diopter into the breech chamber;

[redacted]

(g) fit the diaphragm into the sight eye shield so that the reticle is not doubled;

(h) install the testing target (Fig.100) at a distance of 7±0.2 m from the barrel muzzle face; see that the target is perpendicular to the bore axis and cross 2A28 on the target is at the height of the line of fire with an accuracy of ±5 cm; check the target for proper installation by elevating and depressing the barrel and seeing that the bore-sight cross lines on the muzzel face do not deviate from the vertical line of the target between marks -3° and +5°;

(i) align the gun cross lines with the cross on vertical line 2A28 of the target, in this case the upper crosshairs of the sight reticle should be in line with cross 0° on vertical line 1ПН22М-1, if the crosses are not aligned, align them with the help of the sight adjustment mechanisms;

(j) align the bore-sight cross lines with points +5° and -3° on the target using the gun elevating mechanism, and check the position of the sight crosshairs on the sight. It should be within the tolerance margin shown on the testing target with thick horizontal lines; if otherwise, it is necessary to change the length of parallelogram rod 22 (Fig.97) and perform the checking anew; to change the length of the parallelogram rod, unscrew the collar bolts and turn turnbuckle 32;

(k) the adjustment completed, remove the strip fastening the rod pin on the gun cradle and check the position of the pin in the socket, in case of misalignment, turn the rod by hand until the misalignment is eliminated and check the accuracy anew.

Note. If it is impossible to perform the adjustment with the help of the rod, it is permitted to perform it by turning lever eccentric 6 (Fig. 101). To this end, loosen the nut and screws 40 (Fig. 97) by turning the eccentric tail piece with the wrench, perform the adjustment, and then tighten up the screws and nuts.

Checking of Recoil Oil Presence in Hydraulic Recoil Mechanism

Checking of the hydraulic recoil mechanism consists in adding oil. To this end proceed as follows:

- set the barrel in the horizontal position;
- use a wrench to unscrew filler plugs 26 (Fig.42);
- use the oiler to fill up the recoil mechanism with recoil oil ПЭС-3 (GOST 13004-67) until the recoil oil (polyethylsiloxane fluid) flows out;
- screw in the plugs as far as they will go.

3.2.6. Preparation of Gun for Firing

To prepare the gun for firing, proceed as follows:

(a) remove the cover from the barrel muzzle;

(b) wipe the external surface of the gun;

(c) remove the breechblock (see Subsection 3.2.5);

(d) wipe dry the bore, breechblock and breech ring;

(e) inspect the gun; the bore surface must be free of fouling, dirt, corrosion, traces of lubricant, as well as of visible bulging and cracks;

(f) reinstall the breechblock:,

(g) check the gun electric primer circuits as indicated in Para 3.4.4.

(h) check the operation of the brechblock manual opening and closing mechanism, and close the breechblock by hand;

[redacted]

3.3.1. Design

The coaxial machine gun is mounted in the armour shield on the right side of the gun.

The machine gun (Fig.51) consists of barrel 1, receiver 2, bolt carrier 3 with feeding extractor and gas piston, bolt 4, mainspring 5 with guiding rod 6, trigger mechanism 9, electric trigger 8 and feed-block 10.

The barrel bore is provided with four rifling grooves. In its rear portion it has a smooth cartridge chamber. The exterior of the muzzle end is threaded to receive the flash hider. The gas chamber is installed on two lockpins. A through hole drilled out under the gas chamber serves for escapement of powder gas.

Two cutouts are milled on the barrel lug to receive the receiver lugs.

The gas chamber (Fig.52) is designed for directing a part of powder gas escaping from the bore to the bolt carrier gas piston. Regulator 14 mounted in hole 5 of the gas chamber serves to control the amount of tapped powder gas. The regulator has three grooves of different depth for passage powder gas, and head 12 with three recesses 13 for the retaining pin which are marked 1, 2 and 3. The greater figure indicates the greater amount of tapped gas.

If the bolt carrier does not recoil to the extreme rearward position, the regulator should be set at 2 or under especially unfavourable conditions (low air temperature), at 3.

The receiver (Fig.53) serves for jointing together all the parts and mechanisms of the machine gun. Milled inside the receiver are guiding lugs for directing the motion of the bolt carrier with the bolt, a bevel lug to ensure the initial turning of the bolt, locking recesses against which the bolt lugs rest, an ejection lug for ejecting fired cartridge cases, an opening for ejection of cartridge cases and vertical slots for fastening the electric trigger. The barrel is secured in the receiver by means of the barrel latch with a screw.

The bolt carrier with the gas piston (Fig. 54) serves for actuation of the bolt and for extracting the cartridges from the belt during loading. Fastened in the rear part of the bolt carrier is extractor 7 with hooks. At the bottom of the bolt carrier there is a cocking cam, and in its front part the bolt carrier has a socket for gas piston attachment. The gas piston is located in the gas chamber sleeve.

The bolt (Fig.55) serves to ram the cartridge into the chamber, hit the primer and extract the cartridge case from the chamber. It consists of housing 6, firing pin 9, and extractor 13 with spring 14 and pin 12 with retaining pin 11.

The feed-block (Fig.56) serves for shifting the cartridge belt and delivering the cartridges from the belt into the feed-way. It consists of base 2, feed operating arm 9 and receiver cover 4.

The trigger mechanism (Fig.57) consists of housing 2, sear 4, spring 18, sear pin 3, rocker 6, cam 13, pins 16 of the rocker and cam, safety lock 11 and safety lock retainer 7 with a spring.

The purpose of the sear is to hold the carrier-block in cocked position.

The electric trigger (Fig.58) consists of electriomagnet coil 19, armature 18 with pusher 15, small lever 17 mounted on pin 16, big lever 10 mounted on pin 9, trigger lever 5 with spring 4, safety lock 2 with a thumbpiece and spring 8.

The electric trigger assembly lugs are fitted into the receiver vertical slots and is secured by means of retainer 3.

[redacted]

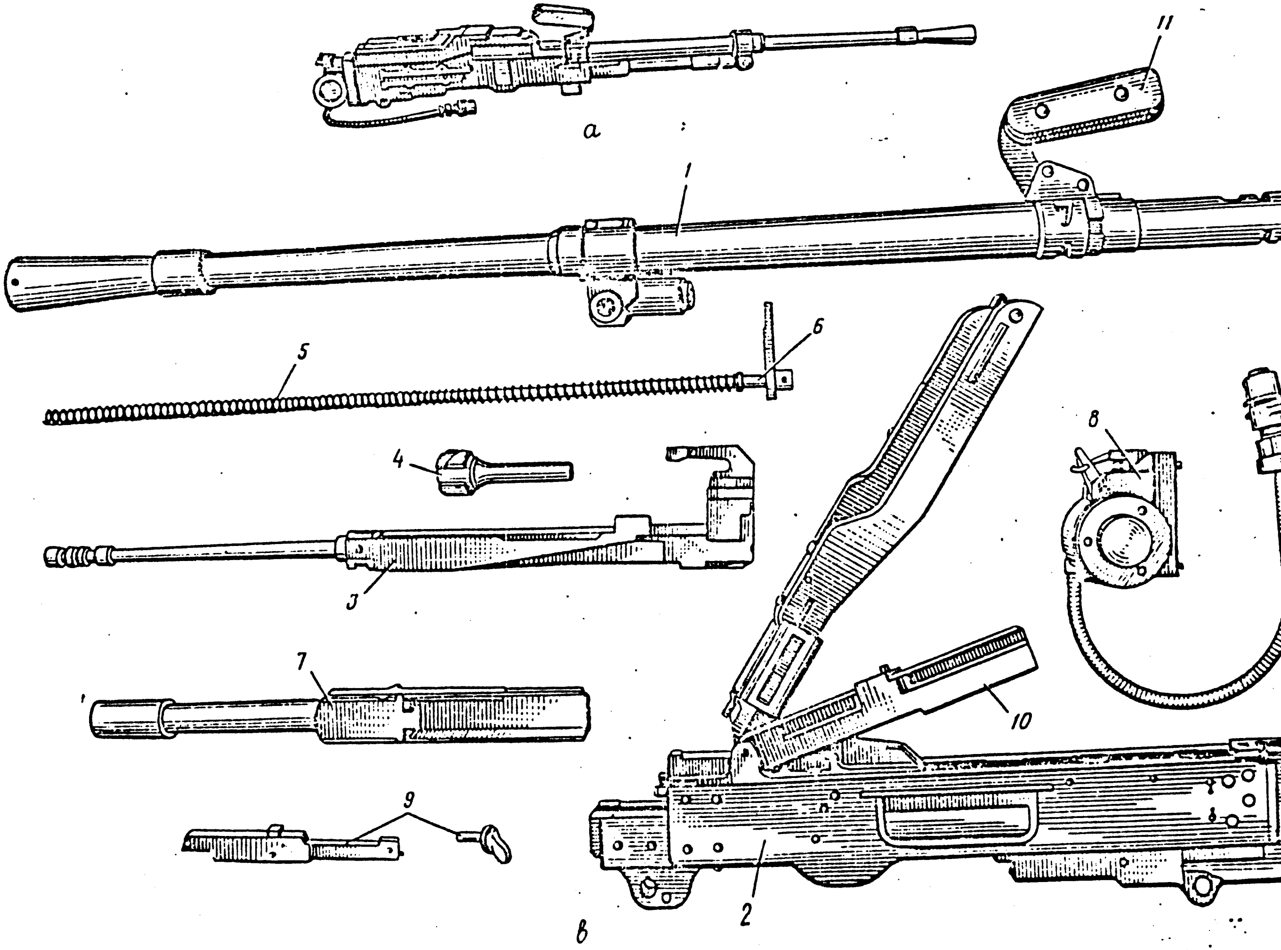


FIG.51. GENERAL VIEW OF MACHINE GUN ПКТ

a - general view; b - exploded view

1 - barrel; 2 - receiver with cover; 3 - bolt carrier with feeding extractor and gas piston; 4 - bolt; 5 - mainspring; 6 - guidingrod; 7 - gas piston tube; 8 - electric trigger; 9 - trigger mechanism; 10 - feed-block; 11 - handle

[redacted]

[redacted]

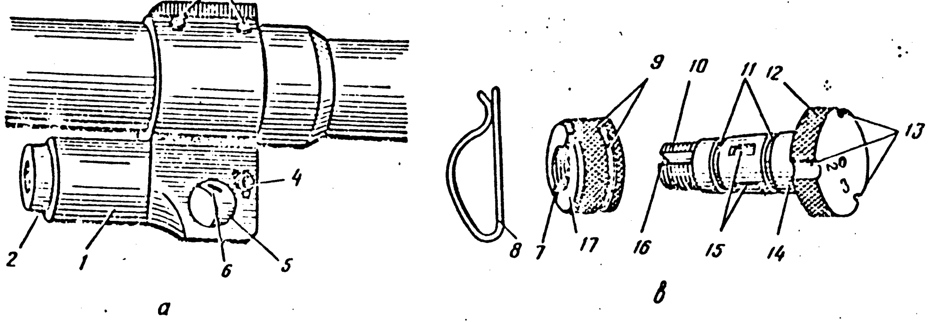


FIG.52 GAS CHAMBER AND REGULATOR

a - general view; b - parts
1 - sleeve; 2 - circular groove; 3 - lockpins; 4 - regulator retaining pin; 5 - lateral hole for regulator; 6 - gas hole; 7 - slit for screwdriver; 8 - wire pin; 9 - slots for wire pin; 10 - thread for nut; 11 - annular grooves; 12 - head; 13 - recesses for retaining pin; 14 - regulator; 15 - gas grooves; 16 - slot for wire pin; 17 - regulator nut

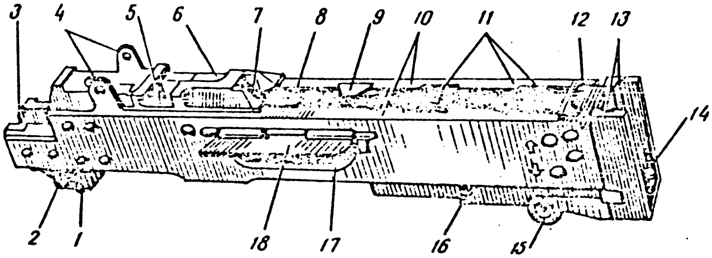


FIG.53 RECEIVER

1 - journals; 2 - holes for fastening machine gun; 3 - recess for spring latch; 4 - ears for fastening receiver cover; 5 - slot for barrel latch; 6 - cutout; 7 - longitudinal recess; 8 - opening; 9 - lugs; 10 - journals; 11 - lugs; 12 - gas piston channel; 13 - bracket for fastening ammunition box; 14 - ears for fastening feed operating arm; 15, 16 - cutouts for fastening machine gun; 17 - opening for ejection of cartridge cases; 18 - guard plate

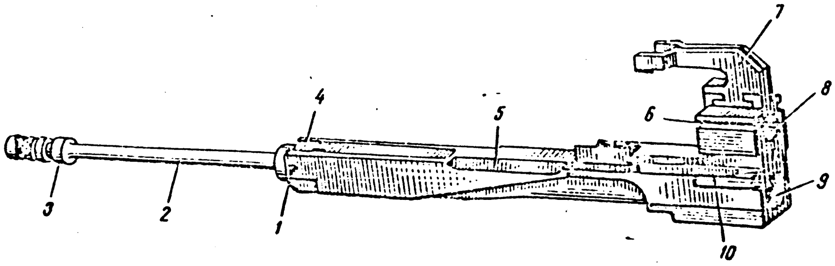


FIG.54 BOLT CARRIER WITH GAS PISTON

1 - lockpin; 2 - gas piston; 3 - guide band; 4 - gaspiston-to-carrier-block connection socket; 5 - cut for ejection of cartridge cases; 6 - longitudinal recesses; 7 - extractor with hooks; 8 - channel for bolt; 9 - mainspring seat; 10 - lug for engagement with guardplate push-rod

[redacted]

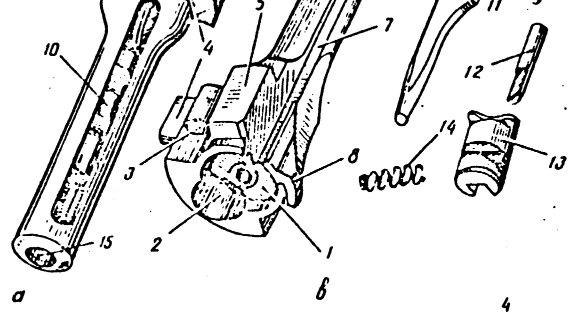
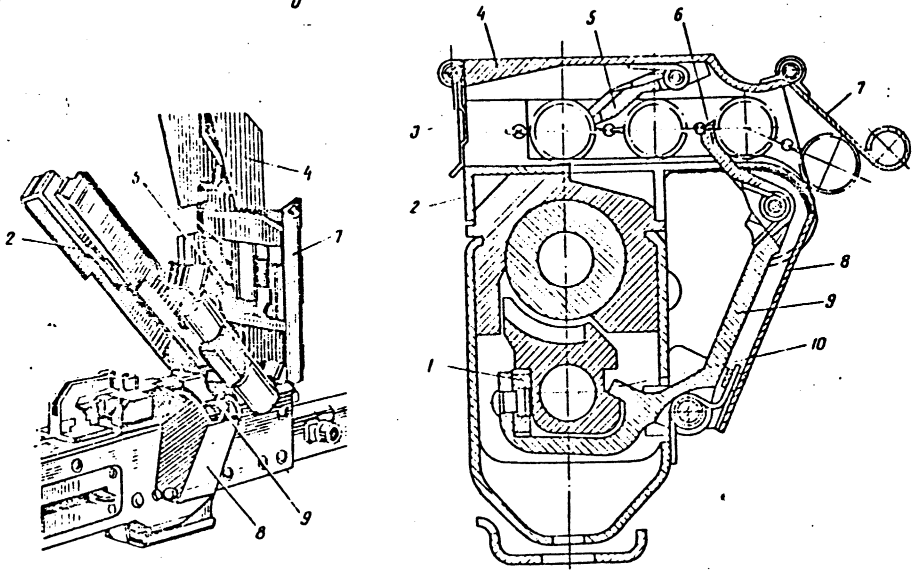


FIG.55. BOLT

a - general view; b - exploded view
1 - recess for cartridge case base; 2 - recess for extractor with spring; 3 - hole for extractor pin; 4 - driving lug; 5 - lugs; 6 - bolt housing; 7 - longitudinal slot for ejection lug; 8 - lug (feed rib) for ramming cartridge case into chamber; 9 - firing pin; 10 - firing pin lug; 11 - retaining pin; 12 - extractor pin; 13 - extractor; 14 - extractor spring; 15 - firing pin channel



FI G.56. FEED BLOCK

1 - feed operating arm roller; 2 - feed-block base; 3, 7 - guard plates; 4 - receiver cover; 5 - upper pawls;
5 - feed pawl; 8 - feed operating arm guard plate, 9 - feed operating arm; 10 - feed operating arm lug

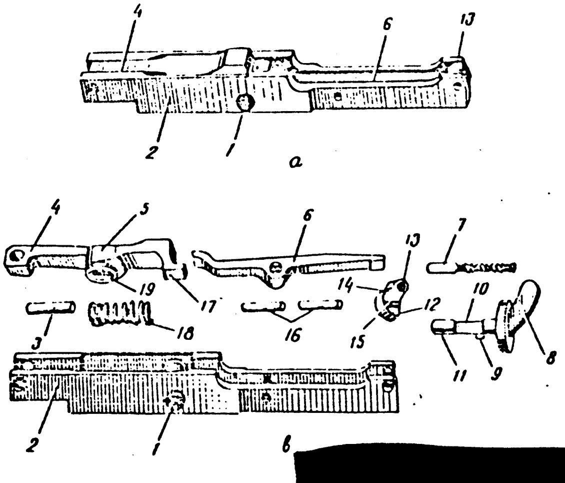


FIG.57. TRIGGER MECHANISM

a - general view; b - exploded view
1 - hole to receive safety lock; 2 - housing; 3 - sear pin; 4 - sear; 5 - sear chamfer; 6 - rocker; 7 - safety lock retainer; 8 - safety lock thumbpiece; 9 - safety lock lug; 10 - wide recess; 11 - safety lock; 12 - cam tooth; 13 - cap; 14 - cam notch; 15 - cam shoulder; 16 - pins of rocker and cam; 17 - sear lug; 18 - sear spring

[redacted]

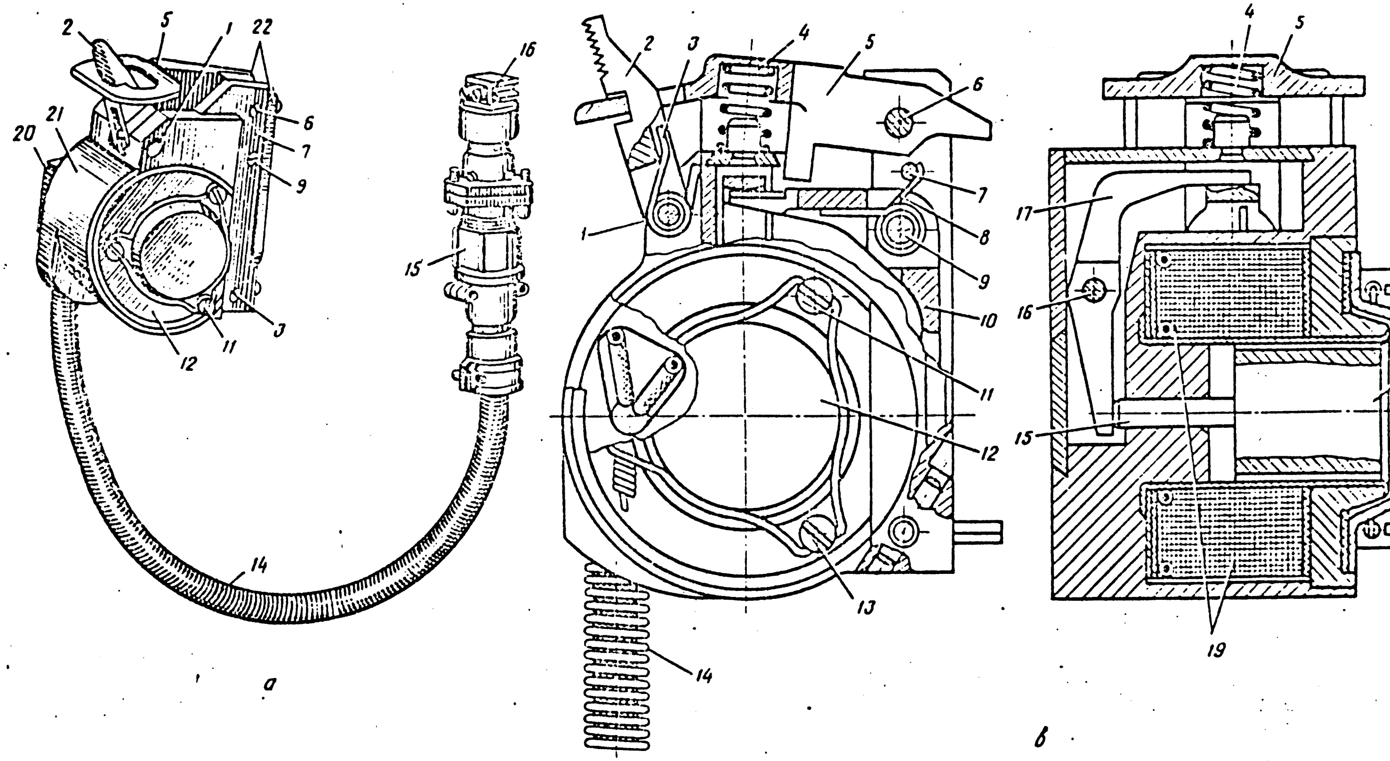

2
5
1
22
21
20
6
7
9
3
11
12
16
15
14
a
2
3
4
5
6
7
8
9
10
11
12
13
1
14
б
4
5
17
16
15
19

FIG.58. ELECTRIC TRIGGER

a - general view; b - sectional view

1 - safety lock pin, 2 - safety lock; 3 - retainer; 4 - trigger lever spring; 5 - trigger lever; 6 - trigger lever pin; 7 - big lever lockpin; 8 - big lever spring; 9 - big lever pin; 10 - big lever; 11 - cover screws; 12 - armature cover; 13 - cover screws; 14 - sheathed wire; 15 - pusher; 15 - small lever pin; 17 - small lever; 18 - armature; 19 - electromagnet coil; 20 - clamp; 21 - body; 22 - guide lugs

[redacted]

slides (22 and 32,respectively), adjusting
chute, counterweights 1 and firing port packing consisting of holder 13 with ball support 14, barrel tube 15, compensating spring 16 and bushing 17.

Bracket 29 is rigidly secured to the gun carriage. The front post of the frame is fastened on the bracket horizontal boom. The rear post of the frame with the screwed-on bushing is installed in the hole of the adjusting mechanism horizontal screw. The boom has an ear to hold the adjusting mechanism which consists of a horizontal screw and two bushings. The bushings have 10 divisions of 1-mil value each. When the machine gun is zeroed turning the bushings sets the position of the bore axis.

On either side of the frame there are guides that carry slides 22 and 32. The slides are coupled with the machine gun by means of cotter pins 23 and 30.

Inserted into the hole of the front slide is a shock absorber consisting of front and rear springs, a bolt and a nut with a locknut.

The shock absorber absorbs the machine gun blowback during firing and returns the weapon to the initial position. When adjusting the effort of the shock absorber springs see that the clearance between the stop and the rear wall of the slide is within 14-18 mm.

The case-and-link ejection chute consists of two casings. The front casing serves to direct the belt. The rear casing is intended for the fired cartridge cases and guides them along spring hose 27 to the case-and-link collector.

3.3.3. Operation of Machine Gun Parts and Mechanisms

Loading

To load the machine gun, proceed as follows:

- turn the handle to the left;
- open cover 2 (Fig.59) of the receiver;

(c) place the belt on the feed-block base so that the first cartridge case rim engages the extractor hooks;

(d) close the receiver cover;

(e) operate retracting handle 4 to pull the bolt carrier as far as it will go, and cock it;

(f) move the retracting handle forward as far as it will go.

In case there is no need in immediate opening of fire turn back the thumbpiece of safety lock 3 so as to prevent the lowering of sear 6 (Fig.60), i.e. to set the trigger mechanism at safe.

When the retracting handle is shifted rearward, bolt carrier 2 compresses the mainspring and moves back the firing pin whose lug enters the circular groove of the bolt carrier post. The extractor hooks remove the cartridge from the belt and carry it backward. When this takes place, the cartridge raises feed operating lever 3 and compresses its spring. As soon as the cartridge case base reaches the feed cam, the cam bevel and the feed operating lever lower the cartridge into the feed-block base feed-way and place it in front of the bolt feed rib.

At the same time the front bevel of the bolt carrier shaped recess acts upon the bolt driving lug, turns the bolt to the left to disengage from the receiver, and draws it backward. At the end of its travel, the bolt carrier acts upon the roller of feed operating arm 9 (fig.56) and bevels of the push-rod of guard plate 8. As a result, the upper part of feed operating arm 9 is turned to the left and feed pawl 6 thrusts against the cartridge belt link, shifts the belt to the left and places the next cartridge against the extractor hooks.

[redacted]

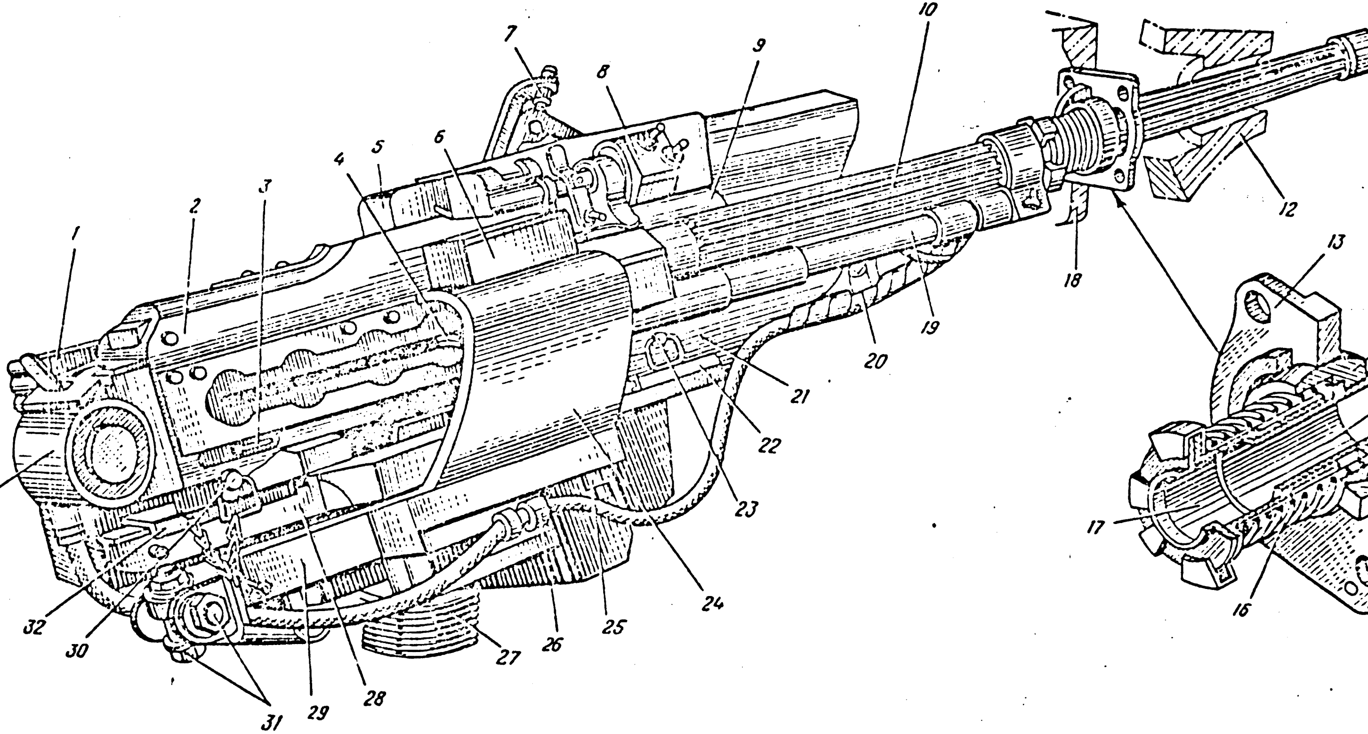


FIG. 59. MACHINE GUN MOUNT

1 - counterweight; 2 - receiver cover; 3 - safety lock; 4 - retracting handle; 5 - gun breech ring; 6 - cover; 7 - gun depression angle limiter; 8 - electromagnet of gun lock latch; 9 - loading angle lock; 10 - machine gun barrel; 11 - flash hider; 12 - armour shield; 13 - ball support holder; 14 - ball support; 15 - barrel tube; 16 - packing spring; 17 - bushing; 18 turret; 19 - gas piston tube; 20 - electric wire; 21 - spring; 22, 32 - slides; 23, 30 - cotter pins; 24 - trough; 25 - nut; 26 - electric trigger plug connector; 27 - empty case-and-link ejection chute; 28 - frame; 29 - bracket; 31 - adjusting mechanism; 33 - electric trigger relay

[redacted]

[redacted]

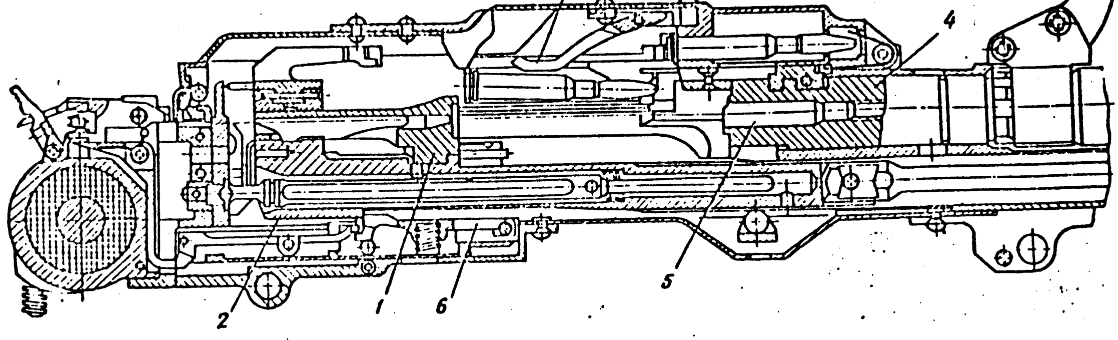


FIG.60. POSITION OF MACHINE GUN PARTS AND MECHANISM BEFORE FIRING

1 - bolt; 2 - bolt carrier; 3 - feed operating lever; 4 - barrel; 5 - cartridge chamber; 6 - sear

Upper pawls 5 of the receiver cover together with feed pawl 6 hold the cartridge belt in the feed-block.

As soon as the bolt carrier cocking cam passes sear 6 (Fig.60), the latter rises under the action of the spring and holds the bolt carrier in cocked position. The machine gun is loaded.

Firing

To open fire, it is necessary to release the safety lock and press the electric trigger push-button or trigger lever. In this case armature 18 (Fig.58) of the electromagnet moves and pusher 15 turns small lever 17. Small lever 17 turns big lever 10 which in its turn actuates trigger lever 5 and disengages the sear from the bolt carrier cocking cam.

Under the action of the mainspring the bolt carrier is pushed forward together with the bolt. The bolt rams the cartridge into the chamber. Under the action of the bolt carrier bevels and recess on its lug the bolt turns about its axis to the right and its lugs engage the receiver locking lugs. Thus the bolt locks the bore. At the same time, the right-hand inclined edge of the bolt carrier acts on the feed operating arm lug and turns the feed operating arm upper part to the right; the extractor hook engages the cartridge case rim; the firing pin striker comes out of the hole in the bolt housing and punctures the cartridge primer. Thus, a shot is fired.

As soon as the bullet clears the gas escape hole, a part of powder gas flows into the gas chamber, pushes the gas piston and throws the bolt carrier backward. The functioning of the mechanisms in this case is similar to that during loading.

3.3.4. Care

Care of the machine gun includes its cleaning, lubrication and elimination of faults.

The machine gun is cleaned after firing and in the course of maintenance of the vehicle.

Prior to cleaning, perform partial disassembly of the machine gun, for which purpose:

[redacted]

[redacted]

before doing this, make sure that the cartridge chamber is empty;

(c) open the receiver cover;

(d) turn the safety lock to FIRE (ОГОНЬ);

(e) detach the guide rod with the mainspring, for this purpose move the guide rod forward until its lug protrudes from the hole, and then raise its rear end and remove it together with the spring from the receiver;

(f) detach the bolt carrier with the bolt, for which purpose move it backward as far as it will go, raise it a little and remove together with the bolt from the receiver;

(g) detach the bolt, to this end, place the bolt carrier so that the bolt faces up, move the bolt backward and turn it to the right so that its lug protrudes from the shaped recess, then move the bolt forward, turn it to the right and detach;

(h) detach the firing pin from the bolt, for which purpose shift the firing pin backward as far as it will go, move it forward by the lug and withdraw the firing pin from the bolt bore;

(i) detach the electric trigger, to this end use a drift to depress the retainer and move the electric trigger upward along the guides;

(j) detach the barrel, for which purpose shift the barrel latch to the left as far as it will go and detach the barrel by turning handle 11 (Fig.51).

The assembly is the reverse of disassembly.

After firing clean the barrel bore with the help of the cleaning rod with the brush screwed on it and moistened in solution РЧС (composition: 1 lit of drinking water, 200 g of ammonium carbonate and 3 to 5 g of potassium bichromate);

Clean the gas chamber and regulator with the regulator removed. To remove the regulator, withdraw wire pin 8 (Fig.52), use a screwdriver to undo regulator nut 17 and drive the regulator out of the hole by slightly striking it with a piece of wood. Wash the gas chamber and regulator in rifle oil and clean the fouling from them with the help of a screwdriver and wooden sticks. Clean gas hole 6 with a wooden stick. After cleaning wipe the parts with waste.

Clean the receiver, gas piston tube, bolt carrier, gas piston and bolt with waste moistened in rifle oil. If there is solidified powder deposit, pour the rifle oil on it and keep it coated with oil for 3 to 5 min. Then, remove the deposit with a wooden stick. After cleaning wipe dry the gas piston, tube and bolt.

Wipe dry also the remaining metal parts with waste.

To lubricate the machine gun, proceed as follows:

(a) lubricate the bore with the help of the brush moistened in lubricant and screwed on the cleaning rod by smoothly running it two or three times through the barrel from the chamber side;

(b) apply a thin layer of lubricant to all other metal parts with the help of oiled waste.

Notes: 1. When lubricating the machine gun under hot weather conditions (at temperatures above +5°C), use rifle oil;
2. Under low temperature conditions when the temperature is +5°C and below (down to -50°C), lubricate the machine gun only with rifle oil. When changing a viscous lubricant by a liquid one, disassemble the machine gun and remove the old lubricant.
3. To wash the parts, use rifle oil.

[redacted]

[redacted]

To zero the machine gun, it is necessary

purpose proceed as follows:

(a) install the vehicle on a level ground;

(b) install a board with the bore-sighting target perpendicularly to the bore axis at a distance of 20 m from the gun muzzle face (Fig.61). In case of vehicles supplied with a reference testing target, perform the checking by the testing target;

(c) operate the laying mechanisms to lay the upper crosshairs of the sight on mark 1ПН22М1 of the target;

(d) turn the turret to the left and to the right to make sure that the crosshairs is kept at the horizontal reference line marked on the target; the temperature correction handle of the sight should be set to 0;

(e) insert the boresighting gauge (ТХП) into the machine gun barrel;

(f) check the laying of the barrel by sighting through the bore-sighting gauge; if the barrel is not laid at mark ПКТ on the target, lay it at the mark by turning the bushings of adjusting mechanism 31 (Fig.59);

(g) without disturbing the machine gun position, tighten up the bushings and make sure that the adjustment is not disturbed.

To zero the machine gun, proceed as follows:

(a) install the testing target (Fig.62) at a distance of 100 m from the gun muzzle face; check the target for proper installation in the horizontal plane by turning the turret to the left and to the right; see that the upper crosshairs is kept at the horizontal reference line on the target;

(b) align mark "6" of the sight scale with mark 1ПН22М1 on the target by operating the laying drives; when laying, move the machine gun from the right to the left and upwards;

(c) fire a burst of four shots, using cartridges of one lot with a heavy bullet or steel-core bullet;

(d) use the bore-sighting gauge and a sighting disc to mark on the target the sighting (aiming) point on which the bore axis is laid (the sighting disc is a white disc attached to a stick; at the centre the disc has a black circle 40 mm in diameter with a central hole for the pencil);

(e) determine the mean point of impact by four bullet holes; if the mean point of impact is located beyond the rectangle on the target, measure coordinates "a" and "c" of the mean point of impact in relation to the reference point (the rectangle centre) and plot them from the point on which the bore axis is laid in the direction opposite to the mean point of impact displacement from the reference point;

(f) put the sighting disc on the obtained point and align the bore axis with the centre of the sighting disc black circle with the help of adjusting mechanism 31 (Fig.59);

(g) lock the adjusting mechanism and fire automatically a burst of ten shots.

The machine gun fire is considered accurate if no less than eight bullet holes are within a rectangle of 14x16 cm (the arrangement of the rectangle sides relative to the board sides is arbitrary) and the mean point of impact of ten shots is within the rectangle of 11x13 plotted on the target. (The mean point of impact is determined by drawing vertical and horizontal lines to divide all bullet holes into two parts, five bullet holes in each part). In case less than eight bullet holes are within the rectangle, i.e. the accuracy of the machine gun fire is unsatisfactory, it is necessary to inspect the machine gun and its mount, check the condition of the barrel and its fastening, make sure that the cartridges are of one and the same lot, and eliminate the faults.

[redacted]

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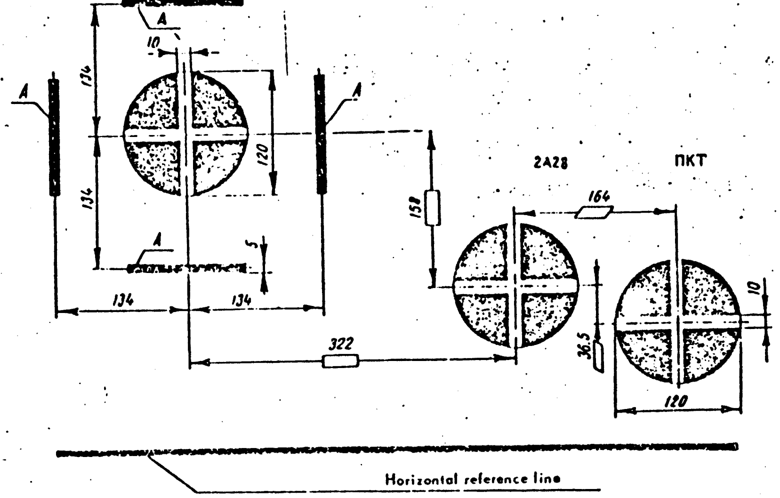
A
10
134
134
120
A
A
A
5
134
134
322
158
2A28
ПКТ
164
10
36.5
120
Horizontal reference line

FIG.61. BORE-SIGHTING TARGET FOR ZEROING MACHINE GUN
A - lines for checking zeroing margins

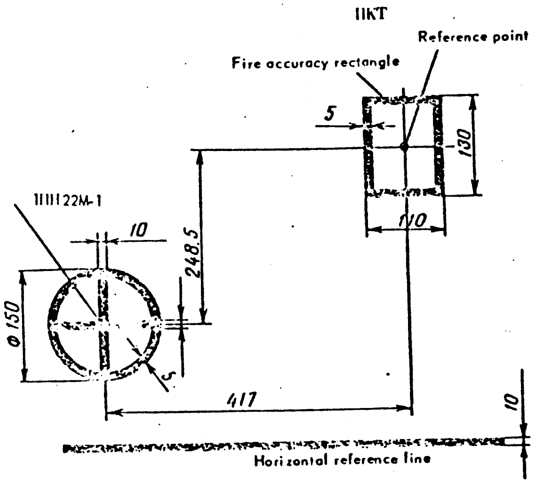
ПКТ
Reference point
Fire accuracy rectangle
5
130
110
ПН22М-1
10
248.5
Φ150
5
417
10
Horizontal reference line

FIG.62 TESTING TARGET

[redacted]

as instructed above (on firing four shots), and fire automatically a burst of ten shots. Check the accuracy of fire.

After zeroing the machine gun secure the bushings of the adjusting mechanism with locking wire, and draw up a reference testing target.

3.3.6. Reference Testing Target

The reference testing target is drawn up to fix the position of the zeroed machine gun.

The reference testing target permits to verify the adjustment of the machine gun without firing.

To make the reference testing target, proceed as follows:

(a) at the centre of a sheet of paper (70x100 cm) draw a circle 12 cm in diameter with a cross for laying the gun, and a horizontal reference line;

(b) attach the sheet to a board installed at a distance of 20 m from the gun muzzle face; check the horizontal setting of the target;

(c) glue a cross of two strings on the muzzle face; open the gun breechblock and insert the diopter into the gun breech chamber and the bore-sighting gauge into the machine gun cartridge chamber;

(d) sighting through the diopter lay the gun on the cross at the target;

(e) use a sighting disc and the bore-sighting gauge to mark the sighting point of the machine gun bore axis on the target;

(f) sighting through the upper crosshairs of the sight scale mark the sighting point on the target with the help of the sighting disc;

(g) describe two circumferences with a 6-cm radius around the sighting points of the sight and machine gun barrel and paint the circles in black colour.

The reference testing target looks like the bore-sighting target (Fig.61) and differs from the latter only in the coordinates of mark "ПКТ" relative to mark 2А28 as it reflects the peculiarities of the machine gun and its mounting in the given vehicle.

The coordinates of the sighting points, location of the bullet holes and mean point of impact of the last burst should be registered in the record card which is kept together with the testing target on the vehicle.

3.4. REMOTE CONTROL TRIGGERS OF GUN AND MACHINE GUN ELECTRIC FIRING MECHANISMS

3.4.1. General

The gun is provided with an electric primer system, while the machine gun has an electric trigger.

The gun and machine gun triggers are actuated by electric current supplied from the vehicle mains. Besides, there are duplicating devices: the gun is equipped with a duplicating generator and the machine gun, with a trigger lever. Electric current is supplied to the firing mechanisms through turret collector ring box and common firing circuit switch TRIGGERS (СПУСКИ) mounted on the turret board. Then, the circuits divide into branches.

3.4.2. Gun Electric Primer Circuit

The supply circuit of the electric primer (gun electric firing pin) consists of a fuse, an electric trigger button arranged on the right-hand handle of the laying drive control

[redacted]

When the gun is laid with the help of the electric drive, deliver fire by using the button arranged on the control panel handle, and when the gun is laid manually use the key.

The gun may be electrically fired by the duplicating generator in case of failure of the vehicle mains power supply source. The duplicating generator is designed to generate a short electric pulse sufficient to cause the functioning of electric primer ЭKB-23A.

The duplicating generator (Fig.63) consists of coil 2 with winding series-connected with diode 13, two shoes 1 and 4, armature 17, armature lever 7 with stops "a", support lever 12 with return spring 9 and spring 14, and handle 8 with catch "b" and rollers 11.

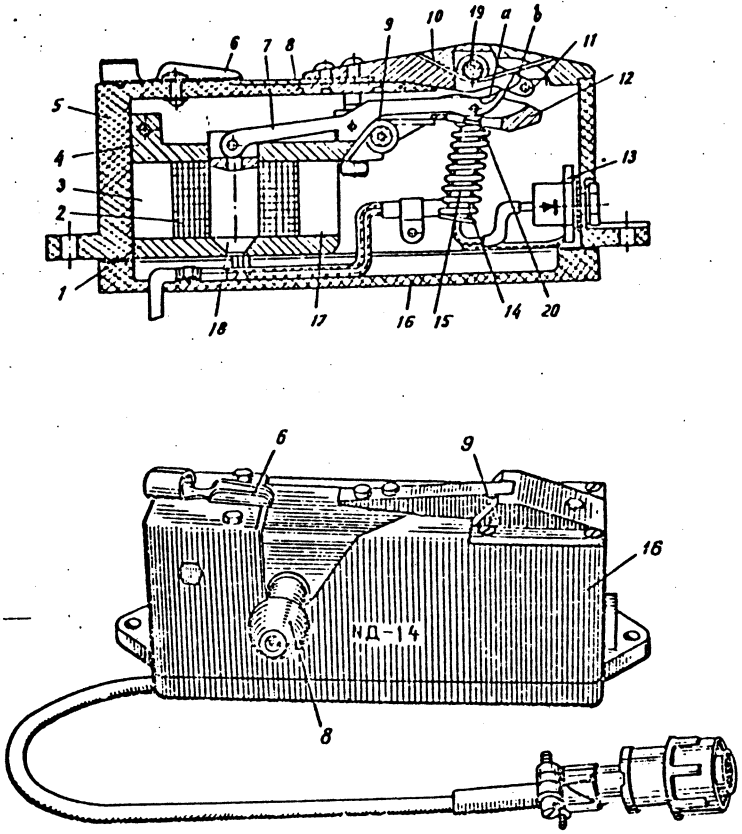

FIG.63. DUPLICATING GENERATOR

1 - lower shoe; 2 - coil; 3 - magnets; 4 - upper shoe; 5 - generator body; 6 - safety catch; 7 - armature lever; 8 - handle; 9 - lever return spring; 10, 14 - springs; 11 - roller; 12 - support lever; 13 - diode; 15 - guide rod; 16 - body cover; 17 - armature; 18 - core; 19 - handle pin; 20 - pin; a - lever stop; b - handle catch

The duplicating generator operates on the principle of electromotive force induction in the coil turns when the magnetic flux changes as a result of the steel armature motion in the magnetic field.

In the initial position armature 17 is located in the taper seat of shoe 1. As handle 8 turns, catch "b" engages stops "a" of lever 7 and holds the lever in the initial position since the armature is pressed against the seat and rollers 11 interacting with support lever 12 compress spring 14. At the same time lever 12 twists lever return spring 9. When the handle

[redacted]

From the coil windings current flows through inner wires [illegible] special connector contacts.

When handle 8 is lowered, spring 9 returns the duplicating generator moving parts to the initial position.

To exclude accidental shots, handle 8 is pressed against the cover by spring 10 and is secured by means of safety catch 6.

To fire a shot, it is necessary to turn the thumbpiece of safety catch 6 either side and pull handle 8 as far as it will go.

3.4.3. Machine Gun Electric Trigger

The electric trigger of the machine gun consists of a fuse located on the turret board, a button arranged on the left-hand handle of the laying drive control panel, a key mounted on the handle of the turret traversing mechanism handwheel, and an electric trigger relay mounted on the machine gun.

To fire the machine gun, the operator presses the button or key depending on the method he employs (i.e. with the aid of the electric drive or manually).

The firing circuit diagram is shown in Fig.64.

3.4.4. Care of Electric Firing Mechanisms

Care of electric firing mechanisms amounts to checking the operation, reliability of fastenings and condition of the electric wires, firing buttons and keys, duplicating generator, as well as to checking the electric primer circuit.

To check the electric primer circuit for proper operation, proceed as follows:

(a) make sure that:
- switch LM on the turret board is at OFF (ВЫКЛ.);
- switch LM on the control panel is at OFF;
- the loading mechanism levers are in the lower position;
- the gun breechblock is closed;

(b) turn switch TRIGGERS on the turret board to ON (ВКЛ);

(c) take the testing lamp from the SPTA set and connect one of its wires to the "ground" and the other one to the central contact of the breechblock wedge (the tail of firing pin 26, Fig.36);

(d) press and release the button on the right-hand handle of the laying drive control panel;

(e) press and release the key on the handle of the elevating mechanism handwheel.

The testing lamp should light up each time the button or key is pressed.

3.5. WEAPON SYSTEM OF ANTITANK GUIDED MISSILE 9M14M

3.5.1. General

Antitank guided missile 9M14M is used to engage armoured targets at ranges from 500 to 3000 m.

The weapon system consists of guided missile 9M14M, a launcher (including a launching bracket and a guide rail), and guidance system 9C428.

The control of the missile and its guidance to the target are effected manually by transmitting commands (signals) from the control panel through wires.

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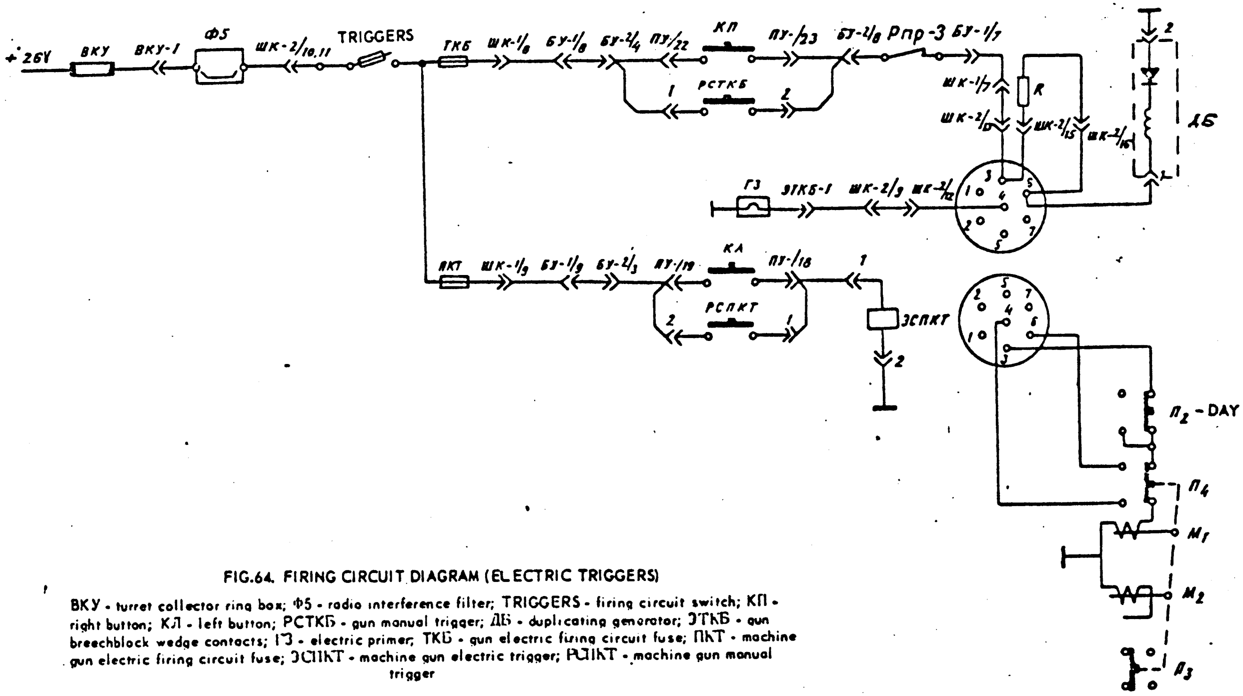
+ 26V
ВКУ
ВКУ-1
Ф5
ШК-2/10,11
TRIGGERS
ТКБ
ШК-1/8
БУ-1/8
БУ-2/4
ПУ/22
КП
ПУ-/23
БУ-2/8
Рпр-3
БУ-1/7
1
РСТКБ
2
ШК-1/7
ШК-2/13
R
ШК-2/15
ШК-2/16
ДБ
2
1
ГЗ
ЭТКБ-1
ШК-2/9
ШК-2/12
1
2
3
4
5
5
7
ПКТ
ШК-1/9
БУ-1/9
БУ-2/3
ПУ-/19
КА
ПУ-/18
1
РСПКТ
2
1
ЭСПКТ
2
1
2
3
4
5
6
7
П2 - DAY
П4
М1
М2
П3

FIG.64. FIRING CIRCUIT DIAGRAM (ELECTRIC TRIGGERS)

ВКУ - turret collector ring box; Ф5 - radio interference filter; TRIGGERS - firing circuit switch; КП - right button; КЛ - left button; РСТКБ - gun manual trigger; ДБ - duplicating generator; ЭТКБ - gun breechblock wedge contacts; ГЗ - electric primer; ТКБ - gun electric firing circuit fuse; ПКТ - machine gun electric firing circuit fuse; ЭСПКТ - machine gun electric trigger; РСПКТ - machine gun manual trigger

[redacted]

fuze consists of head and base portions. The head portion contains a piezoelectric generator which produces an electric pulse upon impact. The pulse is transmitted to the detonator positioned in the base portion. The warhead is coupled with the rocket motor casing by means of locks.

The rocket motor consists of sustainer and booster chambers filled with powder charges and igniters. The thin-walled booster chamber has four nozzles which are inclined to the missile longitudinal axis at an angle of 15°.

To ensure missile spinning in flight, the nozzles are turned in relation to the plane passing through the missile longitudinal axis through an angle of 50'.

The sustainer chamber is a welded thin-walled structure with a heat-resisting coating. The chamber holds a powder charge with an igniter, a delay element and filter 25. Two nozzles are secured in the sustainer chamber bottom portion. The delay element ensures the necessary time delay, whereas the filter is designed for cleaning the powder gas fed to the actuator and reducing its pressure.

The rotor motor functions as follows. When an electric pulse is delivered to the contacts of the booster igniter the booster charge starts to burn. The powder gas is expelled through the four nozzles, thus creating a reactive force which makes the missile move along the launching rack.

As the missile starts moving, push rod 21 (Fig.67) of connector 23 is released to close the contacts used to supply current to the circuit of the sustainer charge igniter. The sustainer charge is ignited and the powder gas flows through the two nozzles to create a reactive force necessary to maintain the missile speed all over the trajectory. The delay element burns out 0.5 to 0.9 s after current is supplied to the igniter, and a part of the powder gas flowing from the sustainer motor passes through the filter and gets into the actuator.

Wing section 5 (Fig.65) consists of a plastic body, four wings with locking mechanisms and a tracer flare holding fixture. The wing section flange is screwed to the rocket motor casing. The wings are hinged to the props of the body by means of pins. During transportation the wings are folded.

After the guide rail with the missile is installed on the launching bracket the wings are unfolded and locked in this position by means of spring-loaded locks.

To fold the wings, it is necessary to press off the washers (protruding beyond the wing surface) as far as they will go along the missile axis, and fold the wing in the direction indicated by the arrow marked WING FOLDING (СКЛАДЫВАНИЕ КРЫЛЬЕВ).

The tracer flare serves to ensure visual observation of the missile in flight. It consist of a body with a tracer composition pressed into it, a cover with electric primers and wires, and a cap.

An electric pulse is supplied to the tracer igniter simultaneously with the pulse fed to the booster igniter. The electric primers operate and the ignition composition starts burning. Then the flame ignites the primary and base tracer compositions. As a result of burning, the pressure increases, thus causing expulsion of the cover and cap.

The red flame of the tracer is seen at a distance of up to 3000 m. The primary tracer composition excludes blinding of the operator at the boost phase of the missile flight as it produces light of lesser intensity.

The control unit consists of an actuator, a gyroscope, a distributor, and a spool with a three-core microcable of the wire communication line. The unit is secured to the sustainer motor flanges with the aid of jetavators passing through the holes of the actuator holder.

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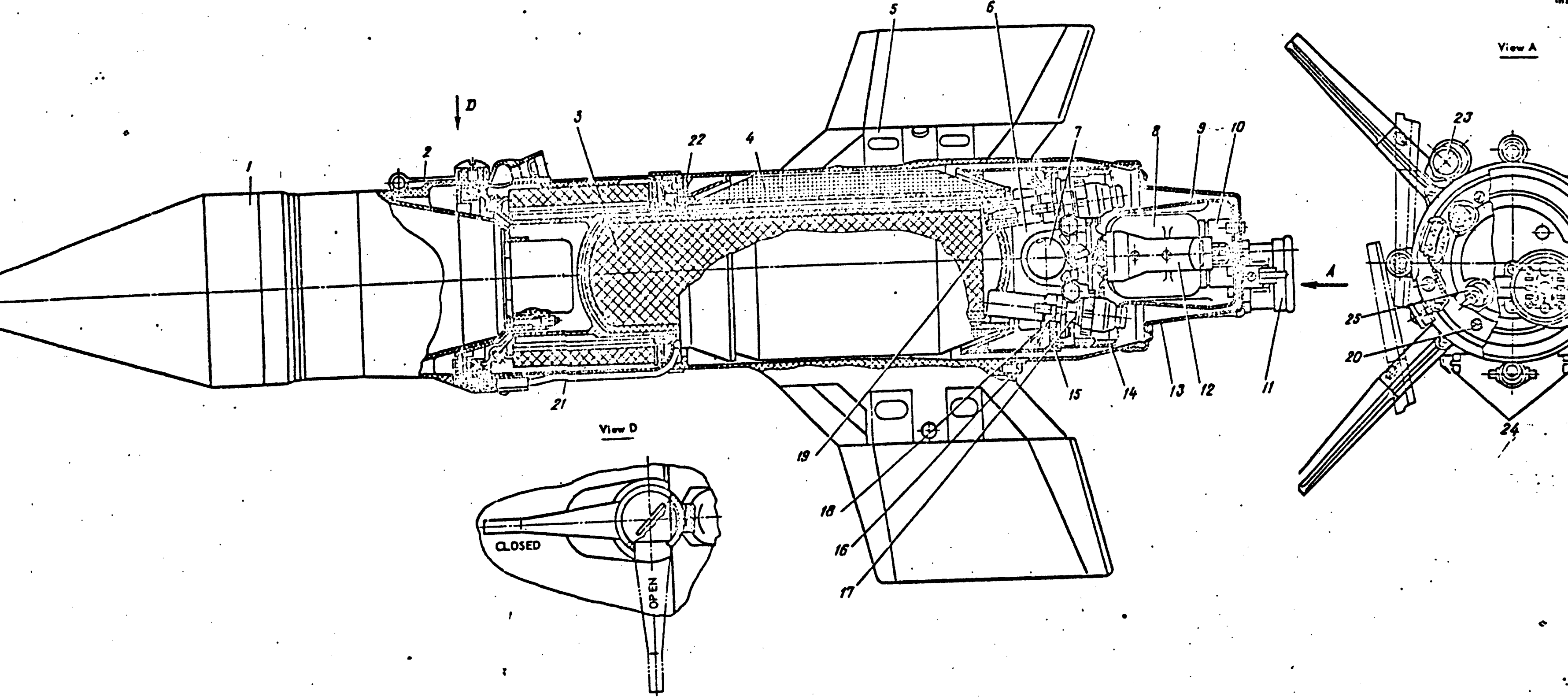
[redacted]


View A
1
2
3
4
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D
View D
CLOSED
OPEN

FIG.65. MISSILE 9M14M (SECTIONAL VIEW)

1 - warhead; 2 - lever; 3 - rocket motor; 4 - spool; 5 - wing section; 6 - distributor; 7 - actuator; 8 - gyroscope; 9 - fairing; 10 - plate; 11 - cover; 12 - resistor unit; 13 - casing with receptacle; 14 - limiter; 15 - coupling; 16, 20, 22 - screws; 17 - jetavator assembly; 18 - bolt; 19 - branch pipe; 21 - tube; 23 - tracer flare; 24 - guide lugs; 25 - filter

[redacted]

tent with the control signals fed from the control panel. It consists of a body housing a slide valve with two electromagnets, a filter and two pistons.

When a control signal arrives from the control panel, current flows alternately through one or the other electromagnet coil (depending on the pulse polarity). The armature of the electromagnet being coupled with the slide valve moves and allows powder gas to pass into the cavities of one or the other cylinder, alternately into the under-piston or above-piston space. The gas flow depends on the polarity of the signal and motion of respective slide valve.

Under the gas pressure (15 to 25 kgf/cm^2) the pistons move and turn the jetavators through their carrier, thereby changing the direction of the gas jets flowing out of the sustainer motor nozzles.

The gyroscope serves for determining the missile attitude in flight and transmitting the obtained data through the wire line to the control panel.

The gyroscope rotor starts spinning at the moment the missile is fired.

The gyroscope consists of a rotor supported in ball bearings, an inner frame, an outer frame, a base frame, an interrupter, a current pickup and a caging device for locking the rotor with a band and the gyroscope frames.

The central part of the rotor has a groove to receive the band designed for rotor spin-up. The free end of the band is attached to the caging device.

When the missile is placed on the guide rail, the caging device is rigidly connected to the launcher by means of a connector. At the instant of launch the caging device gets out of the rotor and frame holes and remains on the launcher. During further travel of the missile along the guide rail the band is unwound from the gyroscope rotor and spins up the latter to an angular speed of 27,000 rpm.

Owing to ability of the gyroscope to maintain the axis of the rotor rotation in a constant spatial position, the outer frame and the interrupter fastened to it do not practically change their position in relation to the missile longitudinal axis throughout the entire missile flight, while the base frame with the current pickup secured in it rotates together with the missile. As this happens, the radial brushes of the current pickup run upon the interrupter to pick up the missile angular position signal. This signal, whose polarity changes every quarter of missile revolution, is used for obtaining the missile attitude data.

The distributor serves for distributing the control signal between the electromagnet coils of the actuator and for supplying rectified voltage to the gyroscope interrupter, It consists of silicon diodes and capacitors.

The microcable spool is a cylindrical framework which carries a wound up microcable consisting of three copper enamelled cores 0.12 mm in diameter. The cores are protected with a fabric sheathing.

The control signals are transmitted from the control panel to the missile through two cores of the microcable, whereas the missile attitude data are transmitted from the missile to the control panel through one core of the information circuit and one core of the control circuit.

The information and control circuits are supplied from the rectangular voltage source of the control panel.

3.5.3. Action of Missile at Launch and in Flight

The missile to be launched is placed on the guide rail of the launcher. The lugs of the missile connector receptacle and the gyroscope caging device are engaged with the launcher retainers.

Pressing button FIRE (ПУСК) sends current to the booster motor and tracer flare circuits. The actuated electric primers set off the powder charge of the booster motor and the tracer composition.

[redacted]

sustainer motor electric

As the missile starts to move, the switching device of the launcher closes the sustainer motor and fuze circuits and the caging device band begins to spin up the gyroscope.

The insert with the microcable end secured in it remains on the launcher together with the connector receptacle. The microcable starts unwinding.

During the boost phase the missile gains the required speed which is maintained by the sustainer motor during the subsequent flight to the target.

Due to the inclined position of the booster motor nozzles, the missile is imparted an angular speed of about 8.5 rps with respect to its axis. In the course of flight this speed is maintained due to the wing inclination and the unwinding of the microcable from the spool.

Sustainer charge ignition sets off the delay element which blocks the entry of the sustainer motor powder gas into the filter. The guided missile flies uncontrolled till the end of the delay element burning. When the delay element has burnt out, a portion of the sustainer motor powder gas passes through the filter and enters the actuator through the gas pipe.

The actuator responds to the command signal transmitted by the operator from the control panel through the microcable, and turns the jetavators. The powder gas flowing through the jetavators shifts the latter from one extreme position to the other, at a certain frequency, thus building up a control moment which imparts the required attack angle to the missile, and the missile performs the required manoeuvre.

The fuze is armed at a distance of 70 to 200 m from the launcher. Upon impact the piezoelectric elements are compressed, thus causing the functioning of the detonator and subsequent detonation of the warhead explosive charge.

The shaped jet produced by the exploding warhead destroys the target.

3.5.4. Launcher

The antitank guided missile launcher consists of a launching bracket and a guide rail. The guide rail together with the missile mounted on it is fastened in the fighting compartment. The launching bracket is secured on top of the gun.

The launching bracket secures the guide rail with the missile placed on it. The launching bracket is fastened with two bolts to boss 3 (Fig.42) of the gun and with another two bolts to the boss of the turret armour shield. It is locked in place by two pins. Bracket 19 (Fig.66) is a cast aluminum structure. Screwed to the bracket upper portion is plate 1 with two slots to guide and secure the guide rail. The front portion of plate 1 mounts a shock absorber consisting of stop 6, strap 3 and two springs 2 fitted on pins 4. Secured in the middle portion of plate 1 is frame 7 which has two longitudinal slots 8. Shafts 14 of connector plug 11 slide in the frame slots. Spring 15 holds plug 11 in the initial position. The plug is closed with cover 10 fixed in place by spring 16.

Mounted in the rear part of plate 1 is retainer 12 with spring 13. The retainer locks the guide rail on the launching bracket.

Fitted in the front part of the bracket in two bronze bushings is the pin of lever 24. One end of rope 20 is fastened in lever 24 and covered with casing 18. The other end of the rope is secured to sight shutter drive pedal 25 (Fig.68). The movement of the lever is limit by two screws 23 (Fig.66). The lever is held in the initial position by spring 21.

The guide rail serves to guide the missile at the launch and is also used to secure it in the stowage place, The guide rail is an aluminum frame consisting of two cheeks 2 (Fig.67 and 41 coupled together by five tie rods 1. Secured to the guide rail cheeks are plate 12, shield 5 and housing 15 which increase the rigidity of the frame. The guide rail is secured in the stowage place by means of front tie rod 1.

[redacted]

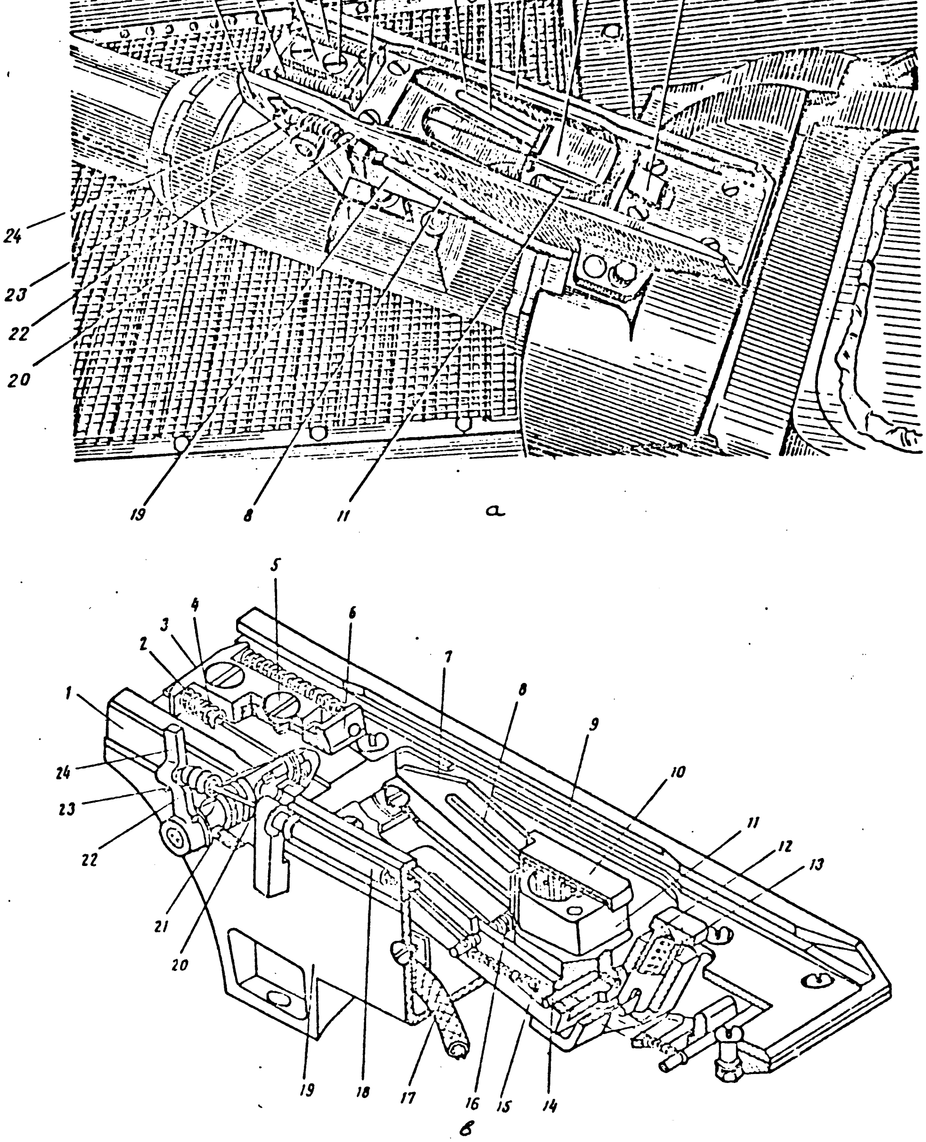
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FIG.66. LAUNCHING BRACKET

a - general view; b - design

1 - plate; 2 - shock absorber spring; 3 - strap; 4 - pin; 5 - screw; 6 - stop; 7 - frame; 8, 9 - slots; 10 - connector plug cover; 11 - connector plug; 12 - retainer; 13 - retainer spring; 14 - shaft; 15 - spring of plug, 16 - spring of plug cover; 17 - cable; 18 - rope casing; 19 - bracket; 20 - rope, 21 - lever spring; 22 - corrugated packing tube; 23 - limiting screw; 24 - lever

[redacted]

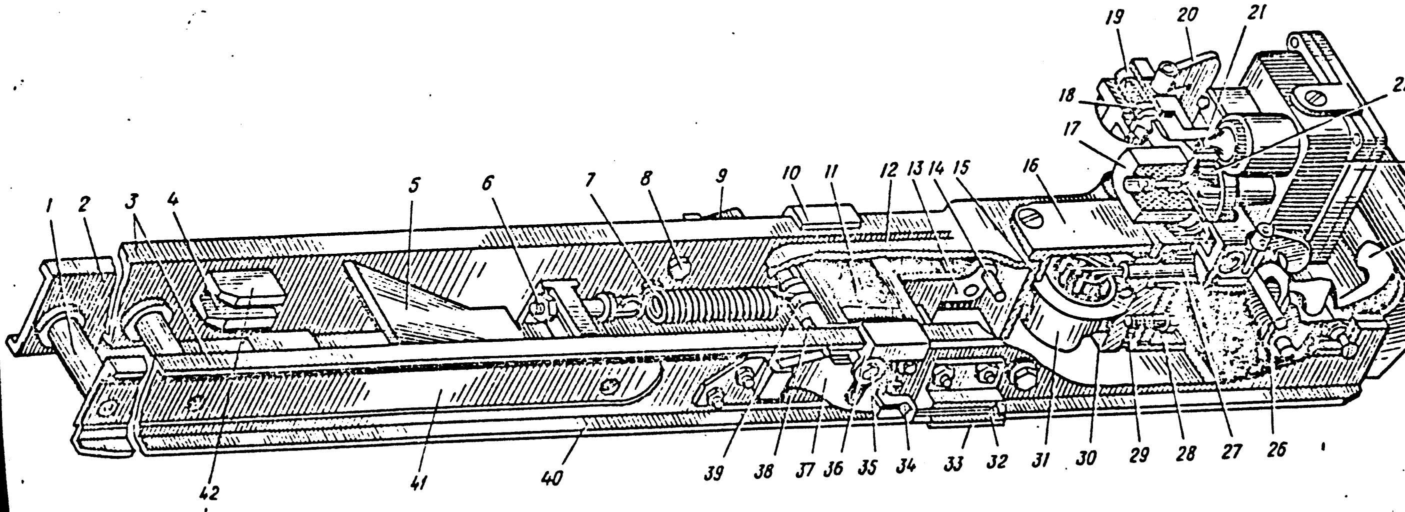
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FIG.67. GUIDE RAIL

1· tie rod; 2 - right cheek; 3 - slides; 4 - slot; 5 - shield; 6 - adjusting bolt; 7 - retainer spring; 8, 28 - bolts; 9 - right retainer; 10 - plate right stop; 11 - handle; 12 - plate; 13 - guide rail stop; 14 - guide rail support; 15 - housing; 16 - receptacle coyer; 17 - connector cover; 18 - connector retainer; 19 - retainer spring; 20 - retainer shackle; 21 - connector push rod; 22 - connector contact; 23 - connector; 24 - key; 25 - handle; 26 - key spring; 27 - cable; 29 - locking screw; 30 - heel; 31 - receptacle of plug connector; 32 - lock spring; 33 - lock housing; 34 - retainer lock; 35 - axle; 36 - plate left stop; 37 - left retainer; 38 - lockpin; 39 - eccentric; 40 - lower slide; 41 - guide rail left cheek; 42 - bracket

.de lugs of the missile leave the launcher at a time.

The frame mounts the missile locking mechanism, connector 23, receptacle 31 of the plug ınector, two stops 13, handle 25, cover 16 with the packing of receptacle 31, and key 24 :h spring 26.

The missile locking mechanism consists of housing 33, two plates with stops 10 and 36, ı two retainers 9 and 37 mounted on axle 35 and pressed against the stops by springs 7. : rear guide lugs of the missile are clamped between the retainers and stops.

Lock 34 of the locking mechanism moves in housing 33 and is pressed in the initial sition by spring 32.

Secured on axle 35 is eccentric 39 with handle 11 coupled together by lockpin 38. Handle serves to depress retainers 9 and 37 when the missile is emplaced on the launcher guide ıl or removed from it.

Connector 23 is fastened to the frame by bolts 28 so that it can move with respect to the ide rail to match contacts 22 of the connector plug with the jacks of the missile connector.

To mount the guide rail on the launching bracket, it is necessary to insert lower ides 40 of the guide rail into the slots of the launching bracket and move the guide rail ɔng them. Stops 13 of the guide rail open cover 10 (Fig.66) and throw it on support 14 ig.67), heel 30 moves plug 11 (Fig.66) of the launching bracket connector in slots 8 of ame 7, and the guide pins of the guide rail receptacle enter the jacks of launching acket plug 11.

At the same time guide rail stops 13 press against the launching bracket stop and mpress springs 2 of the shock absorber until retainer 12 protrudes beyond the guide rail end.

To disconnect the guide rail from the launching bracket, press key 24 (Fig.67) and, ter the retainer gets depressed, withdraw the guide rail by moving it along the slots.

To emplace the missile on the guide rail, proceed as follows:

(a) remove cover 17 from guide rail connector 23;

(b) remove the protective cap and cover from the receptacle of the missile connector;

(c) disengage lock 34 from retainer 37 by hand, and place handle 11 of eccentric 39 in e forward position;

(d) fit the guide rail slides into the missile guide lugs and move the guide rail forward til it bears against retainers 18 of connector 23;

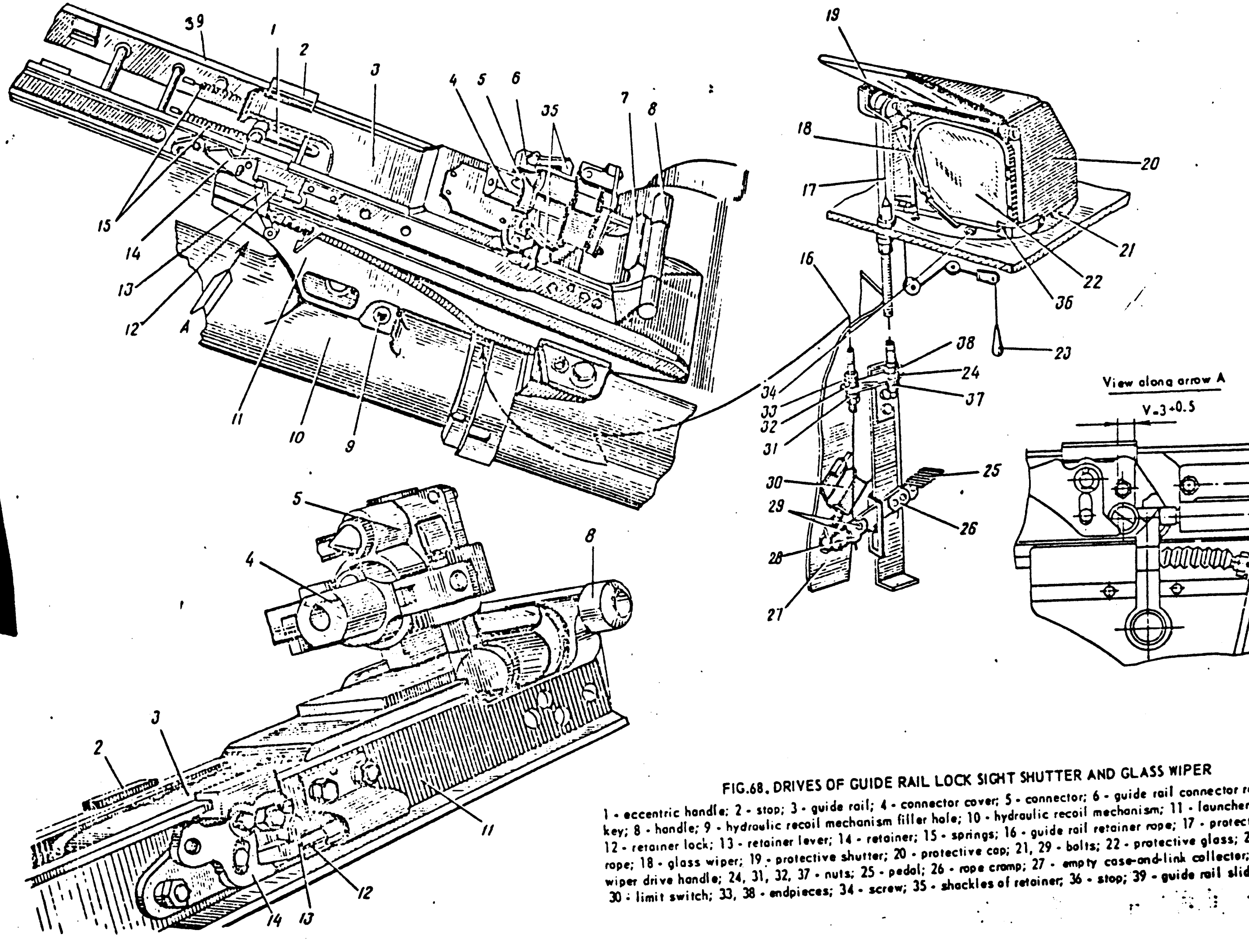
(e) holding the missile by the warhead and connector, press shackles 20 of retainers 18 d move the guide rail as far as it will go without applying excessive effort. The rear ide lugs of the missile should bear against stops 10, and the receptacle lugs should get hind retainers 18.

To remove connector cover 17, it is necessary to take the extractor out of the bag cated behind the operator's seat, and use it to depress shackles 20 of retainers 18. der the action of springs 19 the retainers leave their sockets and catch the missile ceptacle. At the same time the stop at the missile rear presses push rod 21 which ıitches over the connector microswitch.

Then it is necessary to bring handle 11 of eccentric 39 to the rear position. As a :sult, retainers 9 and 37 press the rear guide lugs of the missile to stops 10 and 36 ıder the action of springs 7 and hold the missile on the guide rail. At the same time, ɔck 34 falls into engagement with retainer 37 and securely locks the missile on the guide ıil.

After the guide rail with the missile is placed on the launching bracket, close the ɔver of the missile feed hatch, set change-over switch GUIDE RAILS (НАПРАВЛЯЮЩИЕ) on the ɔntrol panel to "I" and press shutter pedal 25 (Fig.68).

[redacted]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View along arrow A
V-3+0.5

FIG.68. DRIVES OF GUIDE RAIL LOCK SIGHT SHUTTER AND GLASS WIPER

1 - eccentric handle; 2 - stop; 3 - guide rail; 4 - connector cover; 5 - connector; 6 - guide rail connector r
key; 8 - handle; 9 - hydraulic recoil mechanism filler hole; 10 - hydraulic recoil mechanism; 11 - launcher
12 - retainer lock; 13 - retainer lever; 14 - retainer; 15 - springs; 16 - guide rail retainer rope; 17 - protect
rope; 18 - glass wiper; 19 - protective shutter; 20 - protective cap; 21, 29 - bolts; 22 - protective glass; 2
wiper drive handle; 24, 31, 32, 37 - nuts; 25 - pedal; 26 - rope cramp; 27 - empty case-and-link collector;
30 - limit switch; 33, 38 - endpieces; 34 - screw; 35 - shackles of retainer; 36 - stop; 39 - guide rail slid

As pedal 25 is depressed, lever 15 secured on the launching bracket turns, presses lock 12 and disengages it from retainer 14 of the guide rail, thereby clearing way for the missile. Limit switch 30 operates to allow the launch.

Upon depression of button FIRE (ПУСК) on the control panel the missile starts moving along slides 39 of the guide rail under the action of the booster motor. At the initial portion of the missile movement push rod 21 (Fig.67) of connector 23 gets released. Under the action of the spring the push rod switches over the microswitch, thereby closing the circuit of the booster motor and fuze.

Moving further, the missile depresses retainers 9 and 37, and its front and rear guide lugs leave the guide rail simultaneously due to the cuts in slides 3. As this occurs, the missile receptacle with the wire line end secured in it remains on the guide rail and is held in place by retainers 18 of connector 23.

3.5.5. Guidance System 9С428

Purpose and Design

The guidance system (Fig.69) ensures monitoring of the readiness for launch, missile launch, shaping of a control signal in compliance with the operator's commands, and missile control in flight.

The guidance system includes the following components: operator's control panel, automatic control unit, voltage stabilizer and distribution box.

Operator's control panel 1 is designed to launch missile 9М14М and to control it in flight. The panel is secured to base 4 (Fig.32) of the operator's seat.

In the working position the panel is raised and is located in front of the operator (Fig.32c).

The panel is a hermetically sealed unit which mounts the following units:

(a) control handle 3 (Fig.69) designed to control the missile in flight;

(b) change-over switch 5 marked GUIDE RAILS (НАПРАВЛЯЮЩИЕ) which ensures the starting of the equipment for launching the missile;

(c) button 2 marked FIRE which applies voltage to the missile electric primer circuit;

(d) lamp 6 marked MISSILE EMPLACED indicating that the electric circuits are ready for launching the missile;

(e) connector 4 (Ш31) connecting the operator's control panel with the distribution box.

The operator controls the missile in flight with the aid of handle 3 of the control panel. The control panel is mounted so that it can move in various planes. When the control handle is shifted to the left (right), it acts on the slide of the yaw potentiometer. When the control handle is shifted backward (upward) and forward (downward) it acts on the slide of the pitch potentiometer. The control handle can be also deflected to the intermediate position when the slides of both potentiometers are set in motion simultaneously.

The yaw and pitch potentiometers together with the control panel resistors ensure the required relationship between the angle of the control handle turn and the missile manoeuvre parameters.

Automatic control unit 7 is designed to shape the control signal in accordance with the operator's commands. It consists of the following components:

(a) an electronic unit which shapes the control signal;

(b) relay P1;

(c) two microswitches switching on (off) the linearization and weight-compensation signals;

(d) a fuse opening the automatic control unit circuit when the current exceeds 2 A;

[redacted]

[redacted]

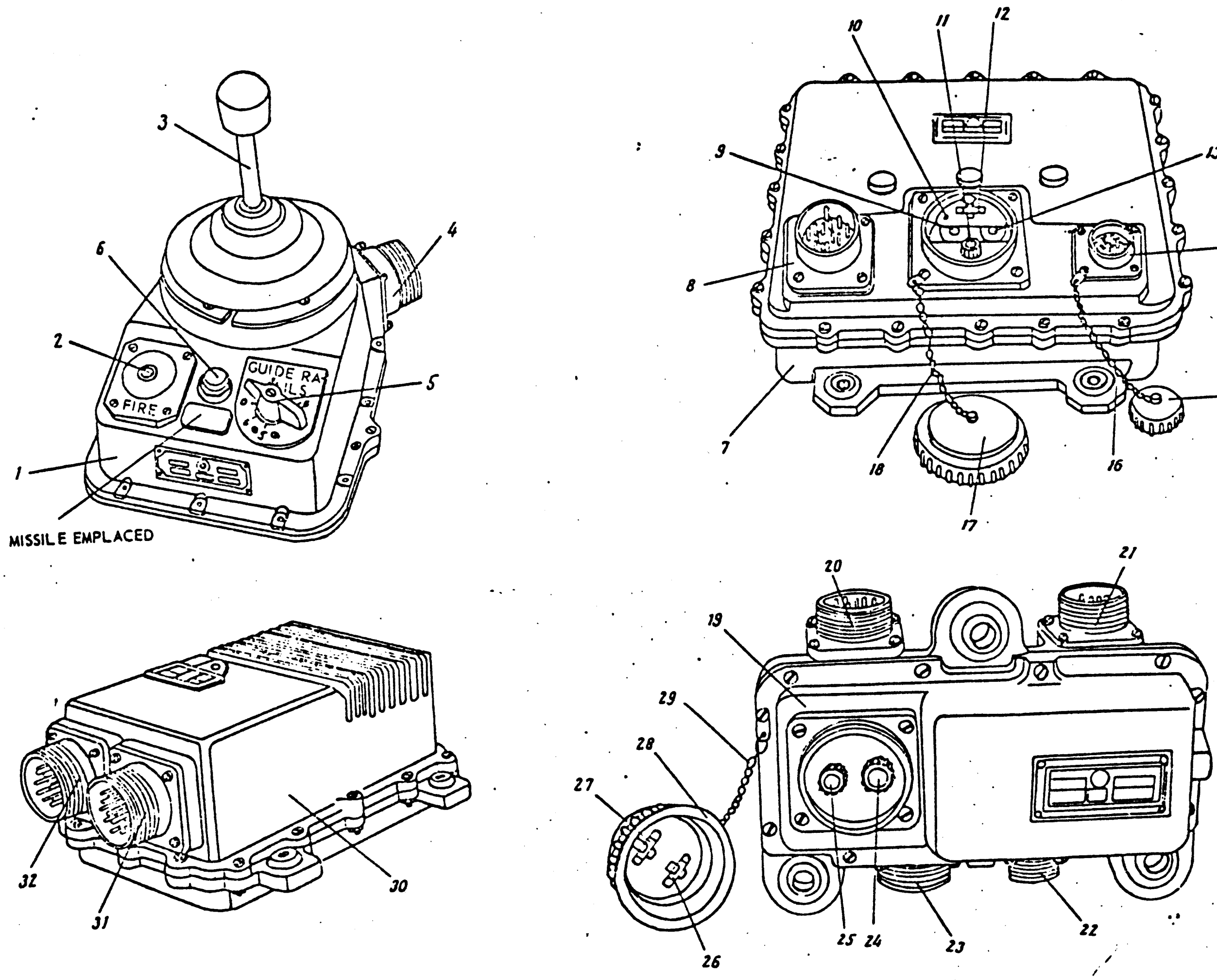
3
6
4
2
5
GUIDE RAILS
FIRE
1
MISSILE EMPLACED
32
31
30
10
11
12
9
8
7
18
17
16
20
21
19
29
28
27
26
25
24
23
22

FIG.69. GUIDANCE SYSTEM 9C428

1 - operator's control panel; 2 - missile firing button; 3 - control handle; 4, 8, 14, 20, 21, 22, 23, 31, 32 - plug connectors; 5 - change-over switch; 6 - signal lamp; 7 - automatic control unit; 9 - linearization signal switch; 10 - strap; 11, 24, 25 - fuse caps; 12, 26, 27 - spare fuses; 13 - weight compensation signal switch; 15, 17, 28 - covers; 16, 18, 29 - cover chains; 19 - distribution box; 30 - voltage stabilizer; 31, 32 - connectors

The automatic control unit is located in the turret to the right of the operator.

Voltage stabilizer 30 is designed for the following:

(a) to supply powder to the automatic control unit (the DC output voltage is within 16±0.6 V with the vehicle mains voltage of 21 to 29 V);

(b) to invert a voltage of 15-16 V into an AC rectangular voltage with a frequency of 1 to 2 kHz and an amplitude of 12±0.6 V;

(c) to rectify the 1-2 kHz AC voltage into a DC voltage of 12±0.6 V.

It consists of an input voltage stabilizer assembled of triodes, a converter composed of a driving oscillator and a power amplifier (triodes and transformers), and a rectifier using diodes with a choke and capacitors.

The stabilizer connects the automatic control unit with the distribution box. It is secured in the turret behind the operator.

Distribution box 19 is designed to connect the control panel with the automatic control unit (through the voltage stabilizer), the control panel with the guide rail connector, and the automatic control unit with the guide rail connector (through the voltage stabilizer). It also serves to turn on the voltage stabilizer and the automatic control unit when the missile leaves the guide rail.

The distribution box comprises three relays, three limiting resistors, a diode, four connectors and two fuses mounted in a sealed unit, which is secured to the turret.

Operation of Missile Guidance System

To prepare the guidance system for operation, transfer the control panel from the lower travelling position into the upper (operating) position and set switch 5 to "I" (with the missile and guide rail installed on the launching bracket). This done, signal lamp 6 (MISSILE EMPLACED) should light up.

To launch the missile, press button 2 (FIRE). In this case voltage is fed from the vehicle mains to the electric primers of the booster motor and tracer flare, and the booster motor is actuated. The missile leaves the guide rail and the sustainer motor starts operating. The control of the missile and its guidance to the target are accomplished by commands transmitted to the missile so as to align the latter with the target.

The operator observes through the sight to keep the missile in the field of view and sends commands to the missile by operating control handle 3. In so doing, he must bring the missile onto the line of sight (the operator-target line) and keep it on this line.

The commands are transmitted from the control panel to the missile through the microcable and are received by the actuator.

When the control handle is turned according to the missile angular position date the control panel generates a control command.

To facilitate the work of the operator and increase the target hit probability, the control panel generates a constant missile weight-compensation command, i.e. when the control handle is in the neutral position constant command UP is transmitted from the control panel to neutralize the gravity effect. The beginning of reception of this command is approximately simultaneous with arrival of the missile at the controlled section of the trajectory (when the powder gas starts to enter the actuator).

A lateral shift of the control handle results in a corresponding change in the direction of the missile flight. When the control handle is pulled the missile ascends, and when it is pushed the missile descends.

After the missile destroys the target the guidance system is automatically brought to the initial position for launching the next missile.

[redacted]

[redacted]

circuit diagram of guidance system 9C428 is given in Fig.70. brief description of this circuit functioning is given below.

According to their purpose, the electric circuits and elements of the guidance syst units may be divided as follows:

(a) a group of missile launching and automatic control unit switching (switching ci cuits);

(b) a group of missile control (control circuits).

The switching circuits are arranged mainly in the distribution box and operator's c panel:

- 33-СД is the electric primer of the booster motor;
- 33-МД is the electric primer of the sustainer motor;
- 33-Тр is the electric primer of the tracer flare;
- 33-ВЗ is the electric primer of the fuze.

In the initial position all relays of the guidance system are deenergized, change-ov switch B1 (GUIDE RAILS) on the operator's control panel is set to 0, contacts 1-2 of chang over switch B1 of the guide rail connector are closed and contacts 3-4 are open. When a vo of 26 V is supplied to the guidance system ("-" of the power source to contact 2 of connec Ш1 of the distribution box, and "+" to contact 1 of distribution box connector Ш1) the cur of +26 V is fed through fuse Пр1, contacts 6 of connector Ш2 of the distribution box and connector Ш31 of the operator's control panel to contact 2 of circuit II of control panel change-over switch B1.

A voltage of -26 V is supplied through fuse Пр2, contacts 13 of connector Ш2 of the distribution box and connector Ш31 of the control panel to contact 2 of circuit I of contr panel change-over switch B1.

Since relays P1 and P2 of the control panel are deenergized, the circuits of the elect primers (contacts 1-4 of distribution box connector Ш4) are shorted by the following circu contact 4 of connector Ш4, normally-closed contacts 1-2 of relay P2 and contact 1 of connec tor Ш4 of the distribution box. Due to the short circuit, the voltage is not applied to the missile electric primers.

When preparing the missile for launching, set change-over switch B1 (GUIDE RAILS) to I. In this case, a voltage of +26 V is supplied through contacts 1-2 of circuit II to th following elements:

(a) contacts 4-3 of button Кн1 (FIRE);

(b) signal lamp Л1 (MISSILE EMPLACED) and contact 7 of connector Ш31.

Then, through contacts 1-2 of circuit III of change-over switch B1 and contacts 1 of connectors Ш31 and Ш2 the voltage is fed to the below elements:

(a) normally-open contacts 3 and 6 of relay P1;

(b) contact 7 of the winding of relay P3;

(c) contact 12 of connector Ш41 through contacts 8 of connectors Ш3, Ш55, Ш56 and Ш38.

A voltage of -26 V is supplied through contacts 1-2 of circuit I of change-over switch B1, contacts 14 of connectors Ш31 and Ш2 is supplied to the following elements:

(a) contacts 8 of the windings of relays P1 and P2 through contacts 11 of connectors Ш3 Ш55, Ш56 and Ш38, normally-closed contacts 4-3 of relay P1 and contacts 10 of connectors Ш38 Ш56, Ш55 and Ш3;

(b) contact 2 of connector Ш55 (voltage stabilizer supply circuit) through normally-closed contacts 4-5 of relay P3 and contact 2 of connector Ш3;

(c) contact 8 of the winding of relay P3 through contact 3 of connector Ш4, normally-closed contacts 12 of missile connector microswitch B1 and contact 2 of connector Ш4.

As this occurs, relay P3 operates and applies -26 V to signal lamp Л1 (MISSILE EMPLACED) through contacts 4-6 of relay P3, resistors R1 and R2, and contacts 4 of connectors Ш2, Ш31. The lamp lights up.

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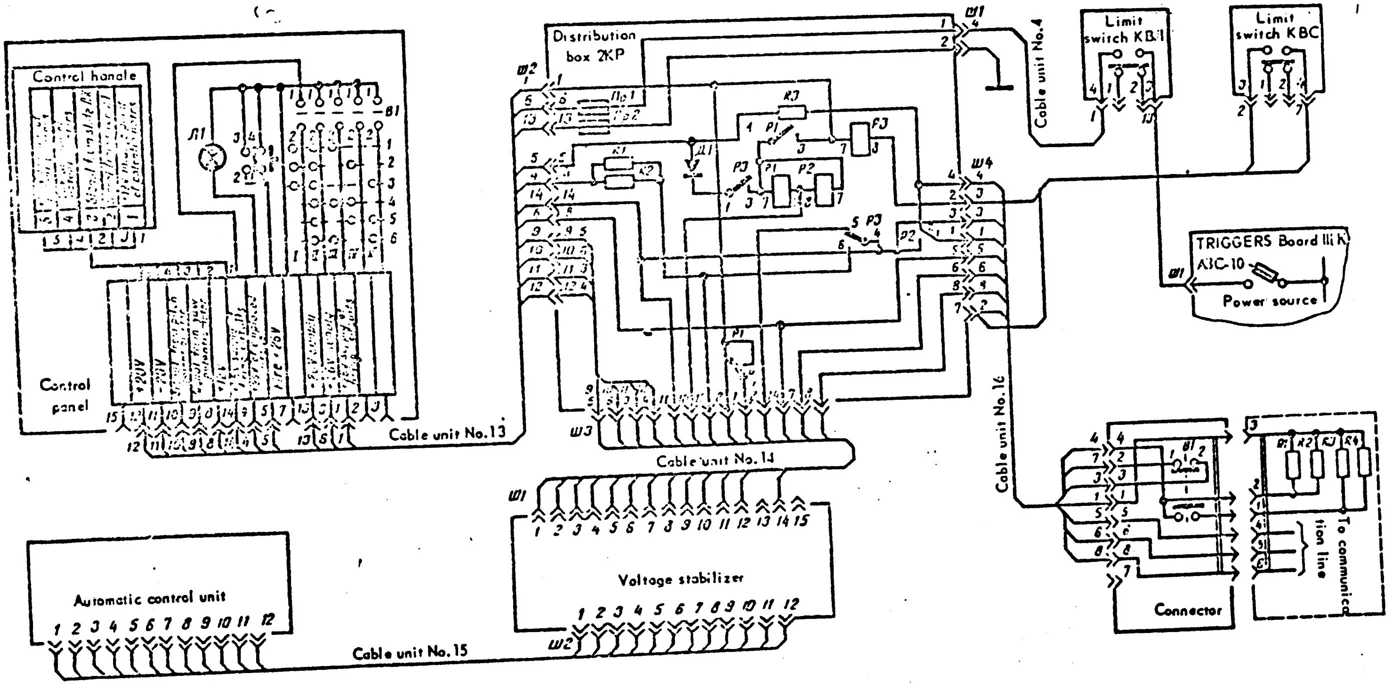
Distribution box 2KP
Ш2
Ш1
Ш4
Ш3
Ш2
Ш1
Limit switch KB1
Limit switch KBC
Cable unit No.4
TRIGGERS Board III K
A3C-10
Power source
Control handle
Control panel
+20V
Л1
B1
Cable unit No.13
Cable unit No.14
Cable unit No.16
Cable unit No.15
R1
R2
R3
P1
P2
P3
Д1
Voltage stabilizer
Automatic control unit
Connector
To communication line
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15

FIG.70. SCHEMATIC CIRCUIT DIAGRAM OF GUIDANCE SYSTEM 9C428

[redacted]

At the same time, when relay P3 operates its normally closed contacts 1-3 prepare the circuit of relays P1 and P2, and normally-closed contacts 4-5 open the -26 V circuit of the voltage stabilizer.

To launch the missile, press button Кн1 (FIRE). In this case a voltage of +26 V is applied through normally-open contacts 4, 1, 3 and 2 of button FIRE, contacts 5 of connecto Ш31 and Ш2 to the following elements:

(a) contacts 7 of the windings of relays P1 and P2 through diode Д1 and contacts 1-3 o relay P1;

(b) electric primers 33-СД and 33-Тр of the missile through resistor R3, contact 4 of connector Ш4 and contact 2 of the missile connector;

(c) normally-open contact 4 of missile connector microswitch B1.

As a result, relay P2 operates and its normally-open contacts 3-1 supply -26 V to all electric primers of the missile through contact 1 of connector Ш4 and contact 3 of the missi connector.

Relay P1 operates and gets interlocked by contacts 1-3. At the same time, its contacts 6-4 apply +26 V to contact 1 of connector Ш55 (voltage stabilizer supply circuit) through contact 1 of connector Ш3.

Electric primers 33-СД and 93-Тр are ignited and the missile leaves the guide rail.

When the missile leaves the guide rail contacts 1-2 of missile connector microswitch open, normally-open contacts 3-4 close and supply +26 V to electric primers 93-МД and 93-В3. The sustainer motor is actuated and the fuze circuit is prepared.

At the same time, contacts 1-2 open the circuit supplying -26 V to contact 8 of the winding of relay P3, and the relay gets deenergized, In this case the following takes place:

(a) a voltage of -26 V is supplied through normally-closed contacts 4-5 of relay P3 and contact 2 of connector Ш3 to contact 2 of connector Ш55 (voltage stabilizer supply circui normally-open contacts 6-4 open the supply circuit of signal lamp Л1 (MISSILE EMPLACED) and the circuit of contact 15 of connector Ш41;

(b) normally-open contacts 1-3 of relay P3 open the supply circuit of relays P1 and P2; but since in this case voltage is supplied to them through contacts 1-3 of relay P1 they remain energized.

After the flight of the missile is completed, relay P1 of the automatic control unit deenergizes relays P1 and P2 by contacts 3-4.

In this case contacts 4-6 of relay P1 cut off 26 V supplied to the voltage stabilizer and automatic control unit, i.e. the system will be brought into the initial condition.

3.5.6. Placing Launcher into Firing Position

To place the launcher into the firing position, proceed as follows:

(a) raise the operator's control panel, for which purpose turn up locking handle 10 (Fig.32) of the control panel, place the control panel in the uppermost position and lower handle 11;

(b) make sure that change-over switch GUIDE RAILS on the operator's control panel is at 0;

(c) move handle 3 (Fig.69) to the upper position by easily turning it about the longitudinal axis until a specific click of the lock is heard;

(d) set the gun at maximum elevation;

(e) remove the guide rail with the missile from the stowage place and put its front end on the supporting rollers mounted on the gun breech end (to facilitate the work, turn the operator's seat);

(f) open the missile feed hatch, holding the guide rail with the left hand;

(g) remove the clip from the missile, move the guide rail with the left hand through the feed hatch into the slots of the launching bracket, and ram the rail as far as it will go until it is locked, check the locking by pulling the guide rail;

[redacted]

wings until they are reliably locked; place the cl removed from the missile into the bag on the empty case collector;

(i) close the missile feed hatch;

(j) turn change-over switch GUIDE RAILS to I.

3.5.7. Laying, Launch and Guidance

To lay, launch and guide the missile, proceed as follows:

(a) place the vehicle on a level ground, if the terrain permits;

(b) close all hatches;

(c) align the centre of the sight day reticle lower crosshairs with the target;

(d) adjust the minimum required illumination of the day reticle by means of lamp rheostat knob 8 (Fig.97);

(e) press pedal 25 (Fig.68); as a result, cable 16 draws retainer lock 12 and shu of protective glass 22 moves down; as this happens, signal lamp MISSILE EMPLACED light the control panel;

(f) press button FIRE on the operator's control panel;

(g) after the missile leaves the guide rail, release pedal 25 to raise shutter 19 protective glass 22 and return the retainer lock to the initial position;

(h) bring the missile on the line of sight, for which purpose catch the missile in field of view of the sight and start guiding of the missile by aligning three points: sight, missile and target.

The missile is guided by operating control handle 3 (Fig.69) on the control panel the missile hits the target.

In case upon depression of button FIRE the missile remains on the guide rail, pres button once more.

If the failure persists, wait for five minutes, then remove the guide rail together with the missile from the launching bracket and put them in the stowage place.

If the necessity to launch the missile has passed, and the situation does not permi place the guide rail with the missile into the travelling position, the movement of the vehicle with the guide rail and missile in the firing position is allowable.

At the first opportunity, however, it is necessary to place the guide rail with the missile into the travelling position.

3.5.8. Placing Launcher from Firing into Travelling Position

To place the launcher from the firing into travelling position, proceed as follows:

(a) set change-over switch GUIDE RAILS on the operators control panel to 0;

(b) depress handle 3 on the control panel as far as it will go by turning it about longitudinal axis;

(c) raise handle 10 (Fig.32), lower the control panel, and then lower handle 10;

(d) set the gun at maximum elevation;

(e) open the cover of missile feed hatch 1 (Fig.30), press key 7 (Fig.68) and draw guide rail inside the vehicle, in case the missile is on the guide rail, fold the missile wings and put the clip on them;

(f) use the extractor to remove the remaining casing with the missile connector rece tacle from the guide rail connector and throw it out together with the wire;

(g) close the missile feed hatch;

(h) close the missile connector contacts with the cover, put the canvas cover on the rail and install the latter into a vacant stowage place seat.

3.5.9. Unloading

To unload the guide rail proceed as follows:

[redacted]

zontally, the missile down;

(b) press off lock 12 of the retainer lever and shift eccentric handle 1 to the extreme forward position;

(c) move the extractor taper edges forward into the clearance between the missile and guide rails connectors and disconnect the connectors;

(d) remove the guide rail from the missile;

(e) shift eccentric handle 1 to the extreme rearward position;

(f) close the connectors with their covers, put the canvas cover on the guide rail and install the latter into the stowage place (in case the vehicle belongs to a training group vehicles it is advisable to remove the guide rails from the vehicles);

(g) fit the safety cap on the missile head and place the missile into the standard packing.

It is forbidden to keep in the vehicle the missiles which are not installed on the guide rails, nor placed in the standard packing.

3.5.10. Care of Launcher and Missile, and Safety Precautions

Care of the launcher and missile includes their regular inspection and cleaning of dust, dirt, snow moisture. Eliminate the faults detected in the course of inspection.

Periodically (every two months), as well as after the missile is exposed to precipitation and water, the missile should be checked for proper operation by specialists using device 9B452. Besides, remove the old grease and apply a fresh layer of grease ЦИАТИМ-201 on the rubber rings of the connectors and a layer of the shell grease on the missile guide lugs.

While handling missiles 9M14M, observe all the safety precautions pertinent to ammunition handling.

In addition to this, it is prohibited to do the following:

(a) to remove the missile from the packing by taking hold of the rubber casing with the missile connector receptacle and the wings;

(b) to thrust against the wings when installing the missile on the guide rails;

(c) to allow unauthorized personnel to disassemble or repair the missile.

To check and adjust clearance V (Fig.68) of the launcher (the clearance between the tooth of retainer 14 and the end of retainer lock 12), proceed as follows:

(a) install the guide rail on the launching bracket;

(b) close the missile feed hatch (Fig.30);

(c) press pedal 25 (Fig.68) until signal lamp 6 (Fig.69) marked MISSILE EMPLACED lights up on the operator's control panel;

(d) without changing the position of the pedal, measure clearance V (Fig.68);

(e) if clearance V is beyond the 2 to 5-mm limits, do the following:

- use a wrench to loosen nuts 31 and 32, with pedal 25 pressed as indicated above;
- holding endpiece 33 set clearance V within 3 to 3.5 mm by turning nuts 31 and 32;
- tighten up the nuts.

(f) in case the above method does not ensure the adjustment of clearance V, do the following:

- tighten up nut 32;
- uncotter and drive out bolts 29, and remove clamp 28;
- set pedal 25 so that signal lamp MISSILE EMPLACED lights up on the operator's control panel, and tension rope 16 so as to ensure clearance V of 3 to 3.5 mm;
- reinstall the clamp and the bolts;
- cotter bolts 29 with wire;

(g) check the clearance on all four missiles of the vehicle.

[redacted]

The firing circuits are checked after every 2400 to 2500 km of run. To check the

circuits, proceed as follows:

(a) turn on switch TRIGGERS on the turret board;

(b) open the missile feed hatch;

(c) remove the protective cover from the launching bracket;

(d) install the guide rail without the missile on the launching bracket;

(e) connect tester 9Б458 to guide rail connector 23 (Fig.67);

(f) close the missile feed hatch;

(g) press push rod 21 of the guide rail connector and pedal 25 (Fig.68) of the sight shutter drive (keep the push rod in pressed position);

(h) place operator's control panel 8 (Fig.32) in the upper position and set change-over switch 5 (Fig.69) marked GUIDE RAILS to I; signal lamp MISSILE EMPLACED should light up;

(i) press button 2 (FIRE) without releasing the connector push rod and pedal of the sight shutter drive; the signal lamp located in the centre of the tester disc should light up and the disc must be motionless, which indicates that the firing circuits of the booster motor and tracer flare are in good order;

(j) release the connector push rod without releasing button FIRE and the pedal, the signal lamp in the centre of the disc is to keep burning, while the tester disc should start rotating and an illuminating diagram must show up on the disc; in this case the automatic control unit is switched off and lamp 6 on the control panel goes out, which indicates that the firing circuits of the sustainer motor and fuze arming are in good order;

(k) draw control handle 3 (by easily turning it) to the upper fixed position and make sure that the illuminating diagrams correspond to the test diagram of tester 9Б458 with the control handle set in the following positions:

- the control handle is in the zero (neutral) position;
- the control handle is pulled all the way back, which corresponds to command UP;
- the control handle is pushed all the way forward, which corresponds to command DOWN;

(l) release button FIRE and the shutter drive pedal; set change-over switch GUIDE RAILS to O;

(m) unscrew middle cover 17 on automatic control unit 7 and remove strap 10, set switch Ж to OFF;

(n) repeat the operations described above and observe the illuminating diagrams with control handle 3 in the following positions:

- the control handle is in the zero (neutral) position;
- the control handle is shifted all the way to the left, which corresponds to command LEFT;
- the control handle is shifted all the way to the right, which corresponds to command RIGHT;

(o) compare the illuminating diagrams;

(p) release buttons FIRE and the sight shutter drive pedal; set change-over switch GUIDE RAILS to O, set switch Ж to ON, reinstall strap 10 and screw on cover 17;

(q) disconnect tester 9Б458 from the guide rail;

(r) reset all the units concerned to their initial positions.

3.5.12. Troubles and Remedies

Trouble	Cause	Remedy
During preparation for launching, lamp MISSILE EMPLACED does not light up on the operator's control	The missile feed hatch is closed untightly	Close the hatch
	The guide rail is not rammed home on the launching bracket	Ram home the guide rail

[redacted]

[redacted]

	Cause	Remedy
panel after the guide rail retainer is unlocked	The connector microswitch is not closed by the missile on the guide rail (the missile is not rammed home)	Ram home the missile
	Burnt out lamp on the operator's control panel	Replace the lamp (MH-26)
	Blown out fuses in the distribution box	Replace the fuses
Upon depression of button FIRE on the operator's control panel the missile does not leave the guide rail	Faulty circuit of the booster motor electric primer	Replace the guide rail w the missile
Automatic control unit cannot be actuated. Upon depression of button FIRE the noise of the automatic control unit operation is not heard	Blown out fuse of the automatic control unit	Replace the fuse

3.6. PORTABLE ANTIAIRCRAFT MISSILE SYSTEM "STRELA-2" (9K32)

The portable antiaircraft missile system (Fig.71) is designed to destroy low-altitude targets flying at speeds of up to 220 m/s.

3.6.1. Brief Characteristics

Mass of system in combat position, kg	14.5
Time required to transfer from portage into combat position, min., s	10
Maximum speed of targets when they can be destroyed on pursuit course, m/s	220
Minimum altitude of targets when they can be engaged, m	50
Maximum altitude of targets when they can be engaged, m	1500
Weight of completed missile, kg	9.15
Length of missile, mm	1423
Mean speed of flight, m/s	430
Time of self-destruction, s	11 to 14

The missile may be launched from the shoulder in the standing or kneeling position through the upper hatches of the troop compartment, both at a short halt and on the move.

3.6.2. Design

The weapon system consists of homing antiaircraft missile 1, launching tube 2, power supply source 3 and launching mechanism 4.

The missile (Fig.72) consists of four sections:

(a) a head section; the head section is an infrared homing head;

(b) a steering section;

(c) a warhead section;

(d) a motor section consisting of ejecting motor 6 and sustainer motor 5. Wings 7 are secured on the nozzle unit of the ejecting motor.

Mounted between the warhead section 4 and sustainer motor 5 is shock absorbing insert 8 designed to absorb the vibratory and shock loads brought about during functioning of the ejecting motor and operation of the sustainer motor in flight.

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Inset 3

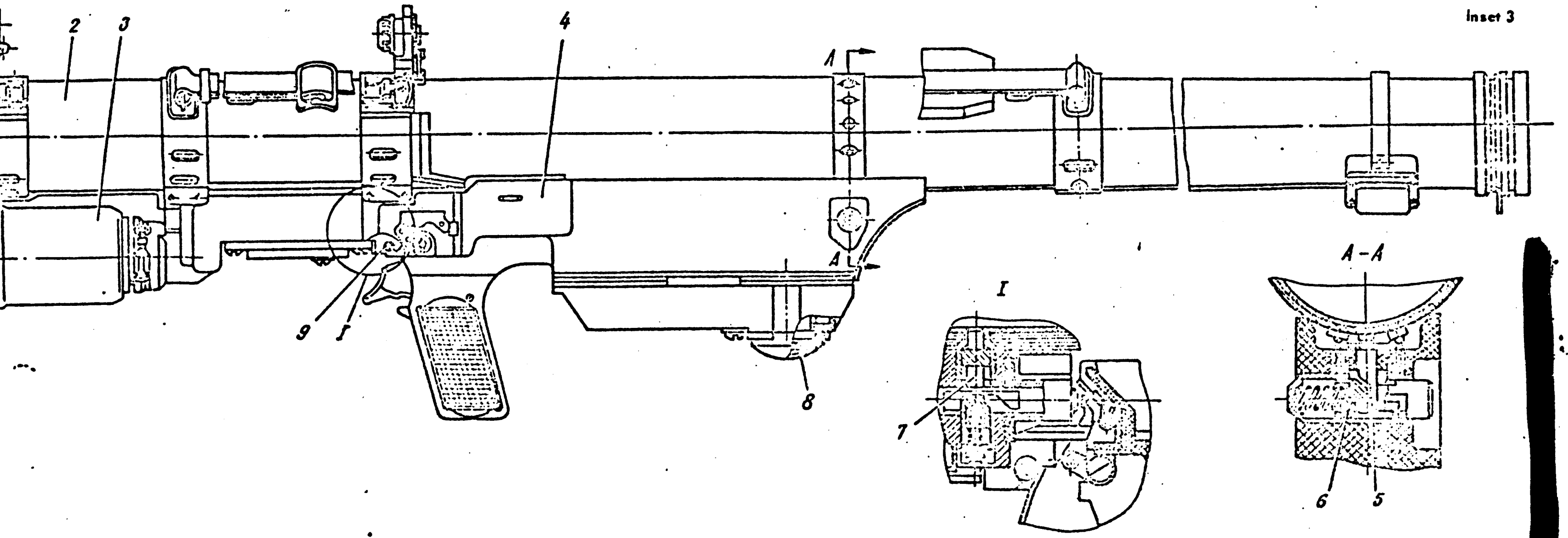

FIG.71. PORTABLE ANTIAIRCRAFT MISSILE SYSTEM 9K32

1 - missile; 2 - launching tube; 3 - power supply source; 4 - launching mechanism; 5 - lock; 6, 7 - retainers; 8 - telephone; 9 - pin; 10 - caging device

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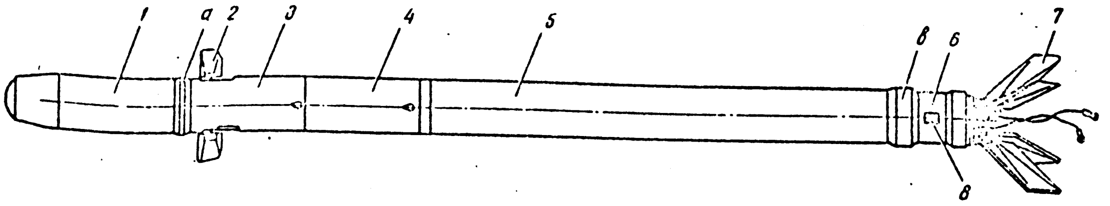

FIG.72 MISSILE 9M32

1 - hominghead; 2 - control surfaces; 3 - steering section; 4 - warhead section; 5 - sustainer motor; 6 - ejecting motor; 7 - wings; 8 - shock absorbing insert; a and b - bourrelets

The infrared homing head is designed to generate a control signal. The infrared homing head is a gyroscopic follow-up device which continuously aligns the optical axis of the seeker objective perceiving the target infrared radiation with the direction to this target.

The homing head consists of a tracking seeker and an autopilot.

The tracking seeker is a complex optical electromechanical device consisting of a two-degree-of-freedom gyroscope whose rotor is an optical unit (objective), and a signal winding unit. Its purpose is to continuously and automatically determine the error angle between the seeker axis and the missile-target line and generate the proportional navigation signal with the help of the automatic tracking gyroscopic system.

The autopilot is a part of a closed-loop missile control circuit and is designed to convert the control signal taken from the output of the tracking seeker electronic unit and to generate a control signal for the control surfaces of the missile.

The steering section is designed to accomodate some components of the missile flight control equipment, and the missile-borne power supply source.

The cartridge-pressure accumulator is designed to feed powder gas to the turbogenerator of the missile-borne power supply source and to the actuator when the missile is in flight.

The cartridge-pressure accumulator operates as follows. The electric igniter operates from an electric pulse and ignites the smoke powder charge pellet. Then, the powder charge is fired. The powder gas passes through the filter to the actuator and turbogenerator.

The actuator serves to throw over the aerodynamic control surfaces from one extreme position to the other so as to control the spinning missile in flight. The throwover angle of the control surfaces is equal to 30°. It acts as a gas amplifier of the control signals generated by the infrared homing head.

The actuator consists of a working cylinder with a piston, a slide valve distributor and two electromagnets.

The electric signal is supplied to the winding of one of the electromagnets which moves the respective slide valve and gives way for the gas into one of the working cylinder cavities. While moving, the piston throws over the missile control surfaces.

The missile-borne power supply source consists of a turbogenerator and a stabilizer.

The turbogenerator is a single-phase synchronous generator excited by permanent magnets.

The stabilizer converts, rectifies and stabilizes the output voltages.

The missile-borne power supply source is actuated by the powder gas coming from the cartridge-pressure accumulator to the blades of the turbine mounted on the shaft of the turbogenerator rotor.

An alternating electromotive force is induced in the stator windings and converted by the stabilizer.

The warhead section consists of a warhead and a fuze.

The warhead is a fragmentation, high-explosive, hollow-charge warhead. It contains an explosive charge and a tetryl detonator.

[redacted]

consisting of an electromagnet with a closing armature and a self-destruction mechanism.

Upon impact of the missile with the target, the closing armature is disconnected from the electromagnet, and current starts flowing in the pulse generator coil to pass to the electric primer. The electric primer operates and detonates the booster charge, warhead detonator and explosive charge.

The warhead section of the missile serves to destroy the target by fragments, high-explosive effect and hollow-charge jet.

The solid-propellant power plant is intended to throw the missile out of the tube, to impart it a rotary motion, to accelerate the missile to a mean speed of 430 m/s, and to maintain this speed until impact.

It consists of an ejecting motor and a dual-thrust sustainer motor.

The ejecting motor is designed to throw the missile out of the tube at a speed of 27 to 31 m/s and to impart it an angular velocity of 19 to 21 rps. The ejecting motor comprises an ejecting charge, delay-action beam igniters, an ejecting motor igniter and a nozzle unit.

The dual-thrust single-chamber sustainer motor is designed to accelerate the missile to a mean speed of 430 m/s under the first thrust setting and to maintain this speed under the second thrust setting.

It consists of a two-grain powder charge and a sustainer igniter located in a thin-wall steel chamber and a plastic sleeve.

The nozzel unit with wings 7 (Fig.72) is secured in the rear portion of the missile. It consists of four wings, wing locking mechanism and four nozzles.

The wings are mounted on axles and secured in the unfolded position by means of spring-loaded retainers. When the missile is in the launching tube the wings are folded. The wings are unfolded at the moment the missile leaves the launching tube under the action of the centrifugal force and locking mechanism springs.

The wings stabilize the missile in flight. They also take part in the creation of the lift.

The nozzles are designed to let through the powder gas of the motors.

The power plant operates as follows.

When an electric pulse comes to the contacts of the ejecting motor the electric primers operate and fire the ejecting charge. The powder gas actuates the delay-action beam igniters. The delay-action beam igniters actuate the sustainer motor igniter at a safe distance from the operator. During the 0.3 s of the delay-action beam igniters operation the missile covers a distance of at least 5.5 m from the operator and the sustainer motor starts operating.

Under the action of the reactive force of the ejecting motor gas the missile is thrown out of the launching tube. The ejecting motor completes its operation before the missile leaves the tube, and then the sustainer motor starts operating.

The missile is placed into the launching tube and bears against the tube walls with its bourrelets "a" and "b" (Fig.72). It is held against axial displacement by retainer 7 (Fig.71).

The missile is electrically connected with the tube by means of a connector and the electric wires of the power plant primer circuits.

The missile control surfaces are held in the folded position by the launching tube wall.

The launching tube (Fig.73) is designed to direct the missile during launch and serves as a missile container.

The launching tube is a cylinder and closed at both ends with protective covers. Secured to the launching tube are power supply source 2, launching mechanism 3, mechanical sight posts, a rotation unit and a connector. The rotor of the homing head gyroscope is caged in the portage position by caging device 10 (Fig.71) mounted in the front cover.

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[redacted]

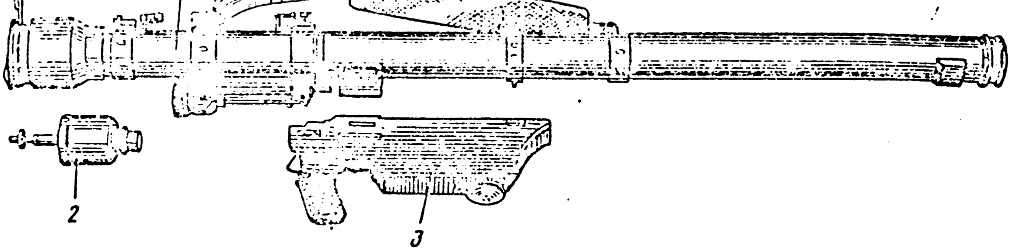

FIG.73. GENERAL VIEW OF LAUNCHING TUBE AND LAUNCHING MECHANISM

1 - launching tube; 2 - power supply source; 3 - launching mechanism

The launching mechanism of repeated use is designed to prepare the missile for launc produce light and audio signals (informing about the homing head locking on the target) a launch the missile. Lock 5 with retainer 6 is provided on the tube to secure the launchin mechanism.

The electronic unit is located inside the launching mechanism. Mounted on the bottom surface of the launching mechanism is telephone 8 designed to produce an audio signal ind ing that the target is acquired.

The expendable power supply source serves to furnish DC voltages of 22 V and 40 V to the electronic unit, the homing head (before the missile-borne power supply source attain its rated duty), the fuze arming circuit, the electric primers of the cartridge-pressure accumulator and the ejecting motor. It is a dry nickel-calcium storage battery.

Screwed into the power supply source body are a primer and a percussion mechanism designed to puncture the primer.

3.6.3. Duties of Crew when Operating Portable Antiaircraft Missile System STRELA-2

General

The weapon system should be always serviceable and ready for use.

The personnel who have not studied the design and operating instructions of the comp should not be permitted to operate the complex. Combat launching may be performed only by specially trained personnel qualified in the established order.

If the missile has been dropped from a height of 0.5 to 1 m inspect it and check separate mechanisms for proper functioning. In this case report the matter through the channels of command and make appropriate entry in the Service Log. When a fault is detect return the missile to the base.

If dropped from a height exceeding 1 m the missile should be removed from the vehicl and sent for repair.

It is strictly forbidden to remove the missile from the launching tube.

It is prohibited to launch the missile when simultaneously there are no lock-on audi and light signals, as well as when the angle between the direction to the target and to t sun is less than 30°. There is no sense in launching the missile when the speed or altitu of the target is beyond the permissible limits tabulated below.

[redacted]

Target	Characteristics of launching and killing zones						
	Altitude, m		Maximum lateral range		Slant ranges as to inner limit of killing zone at minimum altitude, m		Slant ran as to out limit of killing z m
	minimum	maximum	at maximum altitude	at minimum altitude	at zero lateral range	at maximum lateral range	
Jet fighter (of MIG-17 type):	50						3400
V=150 m/s		400	300	500	500	1300	
V=200 m/s		600	450	750	700	1900	
V=220 m/s		1000	1200	1600	800	2600	
Jet fighter (of MIG-19 type):							
V=200 m/s		400	300	500	700	1800	
V=220 m/s		600	350	700	800	2200	
Jet bomber (of IL-28 type):							
V=150 m/s		1200	500	1300	500	1700	
V=200 m/s		1000	750	1250	700	2100	
V=220 m/s		1000	750	1250	800	2400	
Piston-engined aircraft: (of LI-2 type):							
V=100 m/s		1500	1600	2200	500	2200	
Helicopter (of MI-4 type):							
V=50 m/s		1300	800	1500	500	1600	

When the targets fly at altitudes below 50 m the missile may be launched, but the kill probability will decrease due to the ground clutter.

It is prohibited to do the following:

(a) to fully depress the trigger during maintenance and checking operations;

(b) to couple the launching mechanism with the launching tube when the safety lever i at B (FIRE);

(c) to uncouple the launching mechanism from the launching tube with the power supply source operating;

(d) to point the missile to the sun when the cover is removed, since this will result in a failure of the homing head photoresistor.

When connecting the power supply source during operation it is forbidden to turn the handle of the power supply source percussion mechanism cover, since it will cause the functioning of the percussion mechanism.

Safety Precautions

It is strictly prohibited to launch the missile:

- from the standing position if the launching tube elevation exceeds 60°;
- from the kneeling position if the tube elevation exceeds 40°;
- at elevations less than 20°;
- from a launching tube closed with front and rear covers;
- without goggles.

All operations with the missile system brought into the firing position should be performed at a distance of no less than 10 m from people, ammunition and highly inflammable materials.

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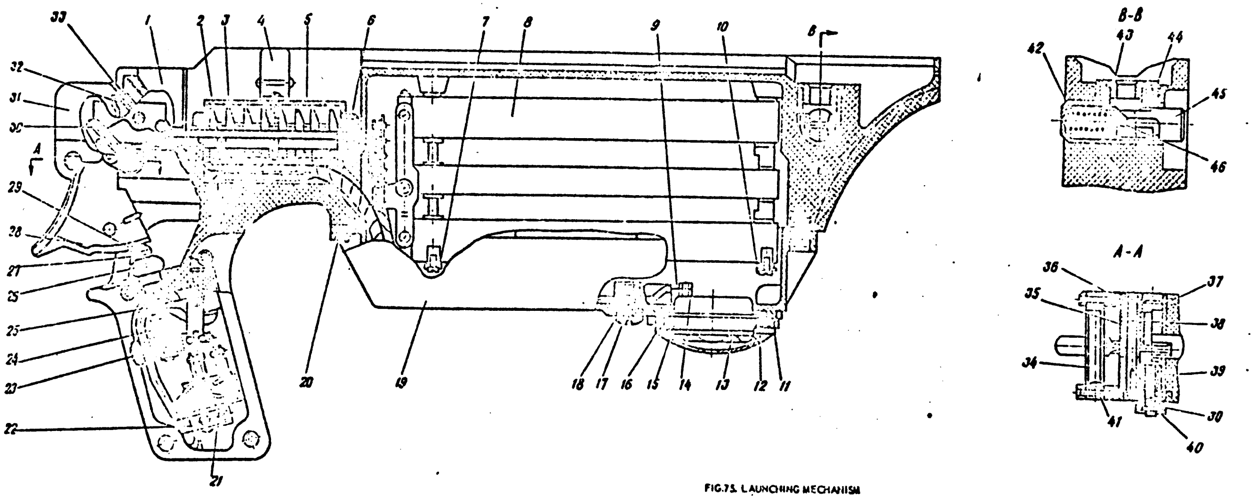

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FIG.75. LAUNCHING MECHANISM

1 - body; 2 - fork; 3 - contact; 4, 24, 38, 39, 42 - springs; 5 - connector cover assembly; 6, 7, 11, 17, 20 - screws; 8 - electronic unit; 9 - endpiece; 10, 29 - washers; 12, 44 - inserts; 13 - gasket; 14 - nut; 15 - telephone; 16, 19 - covers; 18 - packing ring; 21 - contact group; 22 - clamp; 23 - pusher; 25, 30 - levers; 26 - cap; 27 - head; 28 - trigger; 31 - shoulder; 32 - shoulder; 33 - thumbpiece; 34, 36 - pins; 35, 43 - bushings; 37 - shaft; 40, 41 - lockpins; 45 - retainer; 46 - tooth

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Inset 4

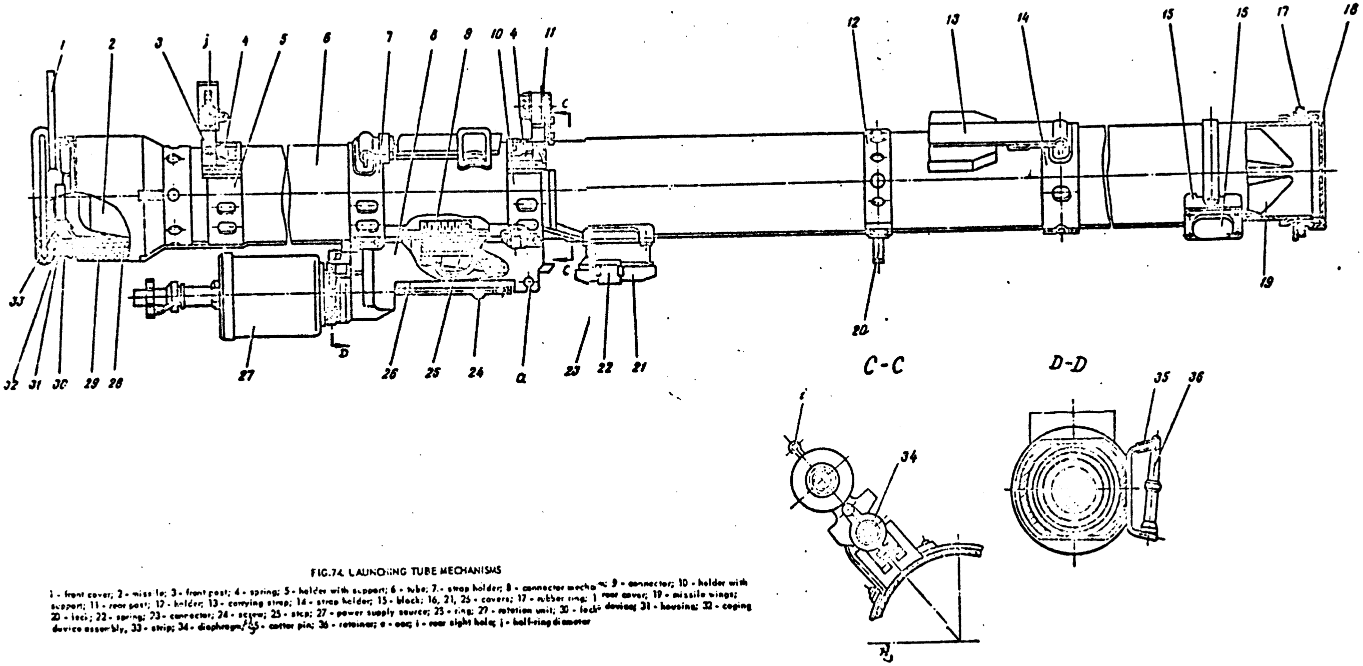
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FIG.74 LAUNCHING TUBE MECHANISMS

1 - front cover; 2 - missile; 3 - front post; 4 - spring; 5 - holder with support; 6 - tube; 7 - strap holder; 8 - connector mecha; 9 - connector; 10 - holder with support; 11 - rear post; 12 - holder; 13 - carrying strap; 14 - strap holder; 15 - block; 16, 21, 26 - covers; 17 - rubber ring; 1 rear cover; 19 - missile wings; 20 - lock; 22 - spring; 23 - connector; 24 - screw; 25 - stop; 27 - power supply source; 28 - ring; 29 - rotation unit; 30 - lock device; 31 - housing; 32 - caging device assembly, 33 - strip; 34 - diaphragm; 35 - cotter pin; 36 - retainer; a - ear; i - rear sight hole; j - half-ring diameter

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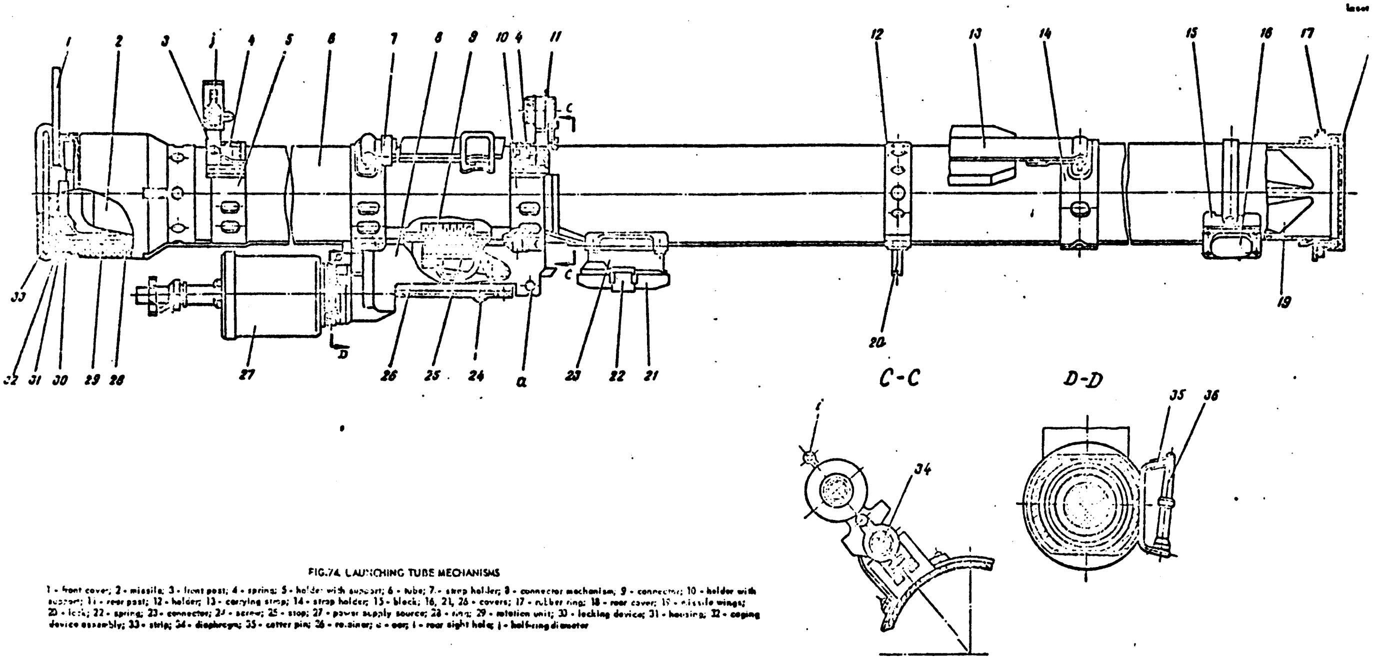
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FIG.74. LAUNCHING TUBE MECHANISMS

1 - front cover; 2 - missile; 3 - front post; 4 - spring; 5 - holder with support; 6 - tube; 7 - strap holder; 8 - connector mechanism; 9 - connector; 10 - holder with support; 11 - rear post; 12 - holder; 13 - carrying strap; 14 - strap holder; 15 - block; 16, 21, 26 - covers; 17 - rubber ring; 18 - rear cover; 19 - missile wings; 20 - lock; 22 - spring; 23 - connector; 24 - screw; 25 - stop; 27 - power supply source; 28 - ring; 29 - rotation unit; 30 - locking device; 31 - housing; 32 - caging device assembly; 33 - strip; 34 - diaphragm; 35 - cotter pin; 36 - retainer; a - ear; i - rear sight hole; j - half-ring diameter

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[redacted]

less than 0.5 m from the rear end of the launching tube.

Never disassemble the used power supply source. While removing the power supply source from the launching tube, take it only by the cover of the percussion mechanism.

Preparation of Weapon System for Launch

To prepare the missile system for use, proceed as follows:

(a) remove the launching mechanism (in bag) from the container;

(b) remove the launching tube with the missile from the container, for which purpose do the following:

- remove the seals from the container cover, take out the cotter pins, release the latc and remove the container cover;
- remove the polyethylene film;
- release the latches and take out the launching tube with the missile;

(c) remove the launching mechanism from the bag and attach it to the launching tube, for which purpose do the following:

- shift spring 22 (Fig.74) backward and remove cover 21 from the tube connector;
- compress spring 4 (Fig.75) and remove cover 5 from the launching mechanism connector
- make sure that lever 30 is at C, and fit pin 34 of the launching mechanism into ear "a" (Fig.74) on the tube body;
- turn the launching mechanism to the launching tube so that lock 20 of the tube engag retainer 45 (Fig.75) of the launching mechanism;

(c) remove the spare power supply source from the container and place it into the launching mechanism bag.

Transfer of Weapon System into Firing Position

To transfer the missile system from the portage into firing position, proceed as follo

(a) remove the front cover 1 (Fig.74) and rear cover 18 from the launching tube;

(b) set posts 3 and 11 of the mechanical sight in the operating position, and make sur that in the daytime diaphragm 34 does not close the signal lamp located in rear post 11;

(c) put on the goggles place the weapon on the right shoulder (Fig.76), press the butt against the shoulder, assume a stable position, and make sure that there are no objects behind the rear end of the launching tube at a distance of no less than 0.5 m.

Launching

The missile may be launched at a halt, from short halts and in movement over an even ground at a speed of up to 18 to 20 km/h.

To launch the missile proceed as follows:

(a) upon detection of the target make sure that it will fly within the launching zone

(b) switch on power supply source 27 (Fig.74) 8 to 10 s before the target reaches the crossing point; to this end turn clockwise the handle of cover 6 (Fig.77) of percussion mechanism 1 so as to bring it from B (armed) to X (safe), a stream of smoke may flow out of the hole of body 11 during the operation of the power supply source;

(c) move launching mechanism lever 30 (Fig.75) from C (stop) to B (fire);

(d) as the target passes the crossing point, lay the launching tube with the missile c the target with the help of the mechanical sight, for which purpose align hole "i" (Fig.74) the rear sight with half-ring diameter "j" or with the hole of front post (sight) 3 (the target passes the crossing point when the operator - target line is perpendicular to the target course; the operator-target sighting line is parallel to the missile longitudinal

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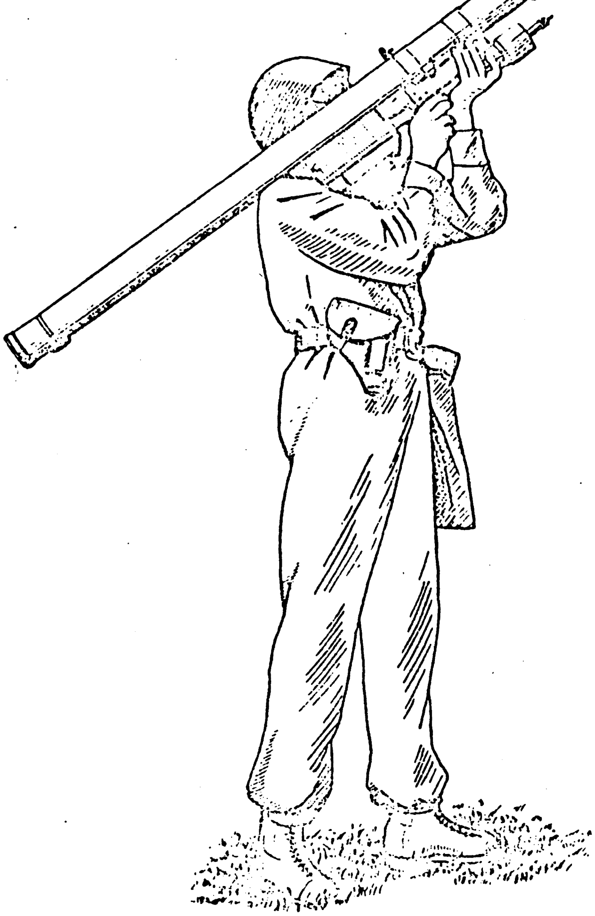

FIG.76. ANTIAIRCRAFT MISSILE SYSTEM 9K32 IN FIRING POSITION

axis, and if the target is in the field of view of the sight it will be also in the field of view of the homing head seeker objective);

(e) as the homing head lock on the target and the light and audio signals appear, pres the trigger to the first fixed position in order to uncage the homing head gyroscope on the fourth second after the target passes the crossing point (the operator must be able to distinguish the signals initiated by a target from those induced by any kind of interferenc the audio signal initiated by a target is of a smooth tone and the light signal has an invariable brightness, whereas the interfering signals are unstable and intermittent);

(f) when sure that the missile head keeps tracking the target, the audio and light signals are present and the target is within the launching zone, apply a lead in the directi of the target flight (an angle of about 10°) and energetically press the trigger home not later than on the sixth second (when firing at low-speed target, it is permitted to uncage the gyroscope and launch the missile immediately upon reception of the target lock-on signal

(g) after the trigger is fully pressed, continue to track the target with the assigned lead until the missile leaves the tube (for 0.8 s);

(h) when the missile clears the tube, release the trigger.

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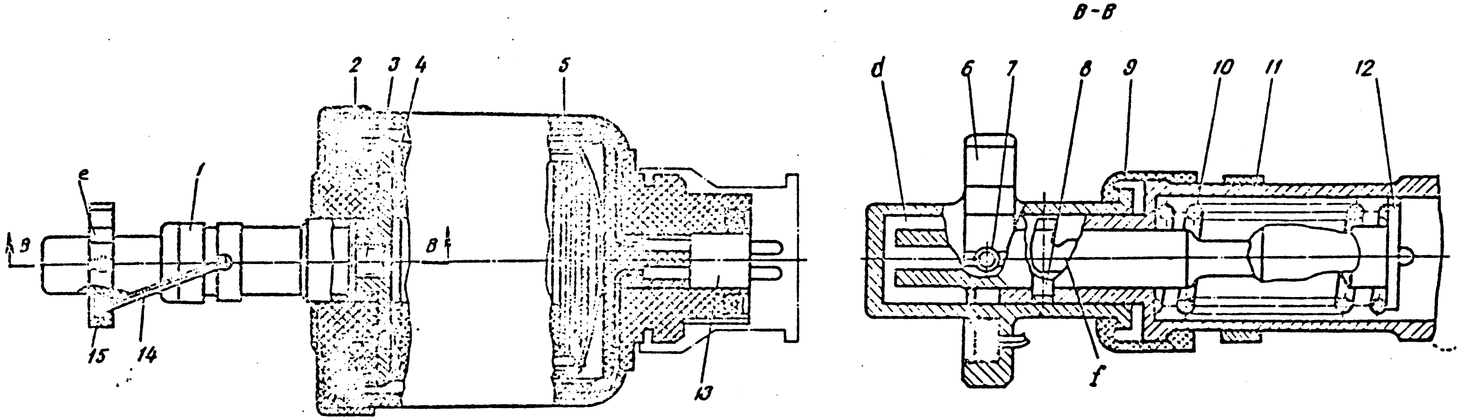
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e
15
14
13
B
B

FIG.77. POWER SUPPLY SOURCE OF MISSILE SYSTEM 9K32

1 - percussion mechanism; 2 - ring; 3 - primer; 4 - storage battery; 5 - body; 6 - cover; 7, 8 - lockpins; 9 - casing; 10 - spring; 11 - body; 12 - striker; 13 - block; 14 - wire; 15 - seal; d, e, f - slots

[redacted]

[redacted]

When the missile is laid on the target and only one signal (audio or light) appears, is permitted to launch the missile.

When the trigger is depressed until the first fixed position and the audio and light signals disappear, do not launch the missile. Release the trigger to the initial position, lock on the selected target by adjusting the aim, or acquire another target and after appearance of the signal launch the missile.

The operator should bear in mind that the total operating time of the power supply source is 40 s and, hence, all lock-on and launching operations should be performed withi this time.

In case the missile is not launched within 40 s, replace the power supply, for which purpose do the following:

(a) shift lever 30 (Fig.75) from B to C;

(b) set posts 3 (Fig.74) and 11 of the mechanical sight into the portage (horizontal position;

(c) remove the weapon from the shoulder and place it with the rear end down;

(d) swing out retainer 36;

(e) compress cotter pins 35 until they come in contact, and detach the power supply source from the launching tube;

(f) remove the transportation cover from the spare power supply source;

(g) mount the spare power supply source on the launching tube;

(h) make sure that the power supply source is reliably secured by cotter pin 35 and lock the cotter pin by retainer 36.

WARNING. During operation the power supply source gets hot and careless handling may cause burns to the hands. Therefore, disconnection of the power supply from the tube with bare hands is permitted by taking hold of cover 6 (Fig.77) of percussion mechanism 1 not earlier than 2 min after it has been turned off.

It is prohibited to disassemble the power supply source.

When trigger 28 (Fig.75) is fully depressed, but the missile fails to leave the laun ing tube, keep the tube at elevation of at least 20° for more than 2 min. Then, place the launching tube with the missile on the ground with the front end face of the tube pointing in the safe direction, detach the launching mechanism and step away from the launchin tube with the missile at a distance of at least 10 m.

Wait for 15 min, then close the end faces of the launching tube with covers 1 (Fig.7 and 18, and connector 23, with cover 26, and send the weapon to the depot.

3.6.4. Care

To care for the missile system, perform the following operations: inspect the launch mechanism, cover and SPTA set, clean and, if necessary, paint them. Check the plug connector and electric wires. See that the contacts are clean.

3.7. ARMAMENT OF TROOPERS

The troopers fire machine guns ПК and submachine guns АКМ through the firing ports c the troop compartment.

3.7.1. Firing Ports

On either side of the vehicle in the troop compartment there is one firing port for machine gun ПК and three firing ports for the submachine guns. Besides, there is one fir port for the submachine gun in the left-hand rear door. The firing ports are fitted with ball supports.

[redacted]

[redacted]

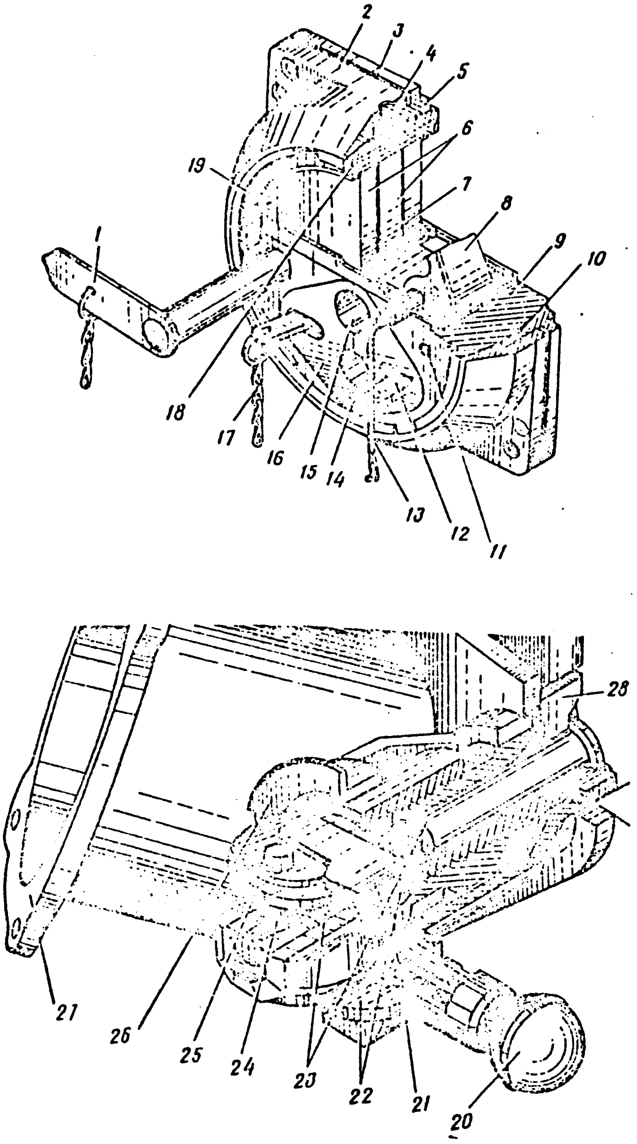

FIG.78. SUBMACHINE GUN BALL MOUNT

1 - handle; 2 - inner faceplate; 3 - gasket; 4 - limiting screw; 5 - outer faceplate; 6 - observation glass; 7 - glass-heating current-conducting layer; 8 - heating device holder; 9 - ball support; 10 - faceplate packing; 11 - lockpin; 12 - lock straps; 13 - heating device electric wire; 14 - lock axle; 15 - submachine gun firing port; 16 - submachine gun lock; 17 - chain; 18 - glass spring ring; 19 - screw; 20 - handle of firing port armour cap; 21 - handle retainer; 22 - handle fork; 23 - pin of armour cap; 24 - stud; 25 - eccentric; 26 - case of firing port closing mechanism; 27 - flange of ball mount; 28 - armour cap

[redacted]

[redacted]

the submachine gun barrel in the ball mount. It consists of two halves hinged together by axle 14. The lock is secured in the ball mount by means of wedges with straps 12 fitted into their longitudinal slots. The wedges are pressed by springs.

To install the submachine gun in the ball support, proceed as follows:

(a) open the armour cap of the firing port by turning handle 1;

(b) set the submachine gun at safe;

(c) remove lock 16 from ball support 9 by pressing straps 12;

(d) separate both halves of lock 16 and fit the submachine gun barrel into port 15 (between them);

(e) press together straps 12 and place the lock together with the submachine gun into the ball support;

(f) remove the empty case deflector from the handle and mount it on the submachine gun

The ball support for the machine gun (Fig.79) differs from the submachine gun ball support mainly in that it is fitted with twin bracket 13 to mount the machine gun. Spring-loaded retainer 12 is installed in ear 9 of the bracket rear portion for the purpose. The front portion of the bracket is secured by means of two bolts 4 passing through the holes of ball support 17. Springs 14 are fitted on bolts 4 to absorb the recoil force during firing.

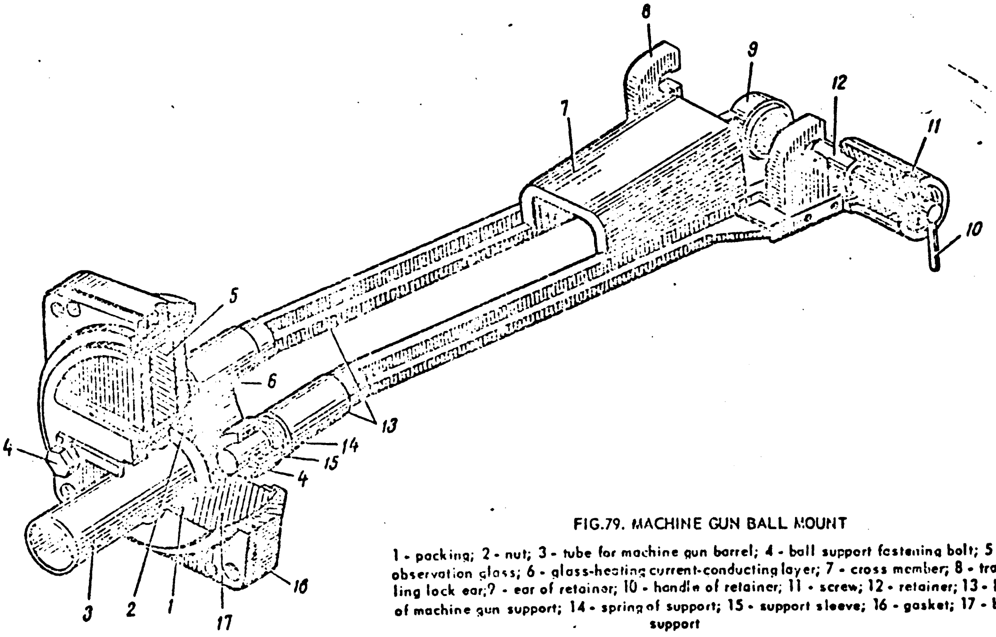

FIG.79. MACHINE GUN BALL MOUNT

1 - packing; 2 - nut; 3 - tube for machine gun barrel; 4 - ball support fastening bolt; 5 - observation glass; 6 - glass-heating current-conducting layer; 7 - cross member; 8 - travelling lock ear; 9 - ear of retainer; 10 - handle of retainer; 11 - screw; 12 - retainer; 13 - bracket of machine gun support; 14 - spring of support; 15 - support sleeve; 16 - gasket; 17 - ball support

In other respects the ball supports are similar in design.

On the outside, the firing ports are closed with armour caps provided with eccentric locking mechanisms. To open the caps on the vehicle left side, pull handle 1 (Fig.78) and turn it clockwise. To open the caps on the vehicle right side, turn the handle counter-clockwise.

[redacted]

[redacted]

(a) pull handle 10 (Fig.79) of the retainer of bracket 13 as far as it will go, and turn it down;

(b) move up bracket 13, remove the lever pins from ear 8, and pull the bracket travelling lock lever;

(c) release the lever; under the action of the spring the lever moves upward;

(d) unfasten the strap and remove the empty case deflector from bracket 13;

(e) set the machine gun at safe;

(f) insert the machine gun barrel into tube 3 of ball support 17 as far as it will go;

(g) fit the right-hand trunnion of the machine gun into the hole of the bracket right-hand cheek, and insert retainer 12 into the machine gun socket;

(h) install the empty case deflector on the machine gun.

In the travelling position, when the firing port cap is closed, the bracket travelling lock lever should be lowered and hold the bracket by ears 8. In firing position, the firing port cap should be open, the machine gun released from safety and the lever raised.

3.7.2. Small Arms Using Regulations

The regulations governing the use of troopers' armament are as follows:

(a) load the machine guns and submachine guns only after they are installed in the ball supports;

(b) before firing the weapons switch on the ventilation system, for which purpose turn the thumbpieces on the ventilators counterclockwise; the description of the ventilation system is given in Section 11;

(c) to fire the machine guns, remove the 100-cartridge magazines from the stowage place and put them on the machine guns, fit the 200-cartridge magazines with open covers into the stowage places arranged under the stowage places for the 100-cartridge magazines;

(d) remove the cartridge cases from the empty case collectors after every 200 shots;

(e) unload the machine guns and submachine guns without withdrawing them from the ball supports;

(f) in case upon completion of firing it is required to remove the machine gun from the bracket, first free the empty case collector of fired cartridge cases and remove it from the machine gun;

(g) after firing, collect all fired cartridge cases from the vehicle bottom so as to exclude jamming of the loading mechanism conveyer by them.

3.7.3. Maintenance of Ball Supports

Maintenance of the ball supports includes cleaning and lubricating operations.

To clean the ball support observation glasses, proceed as follows:

(a) remove the weapons from the firing ports;

(b) turn spring lock ring 18 (Fig.78) of the glass and remove the glass;

(c) clean the glass and the socket, and reinstall the glass.

To clean and lubricate the spherical surfaces of the ball supports proceed as follows:

(a) remove the weapons from the ball supports;

(b) use a wrench to unscrew four bolts 4 (Fig.79), and remove ball support 17;

(c) drive out four screws 19 (Fig.78) and disconnect faceplates 2 and 5;

(d) remove ball support 9;

(e) clean the spherical surfaces of the ball support, faceplates and slot for the spring ring, and wipe them with clean waste, in winter, coat them with grease ЦИАТИМ-201; no lubrication is needed in summer;

(f) assemble the ball support and reinstall it.

[redacted]

[redacted]

[redacted]

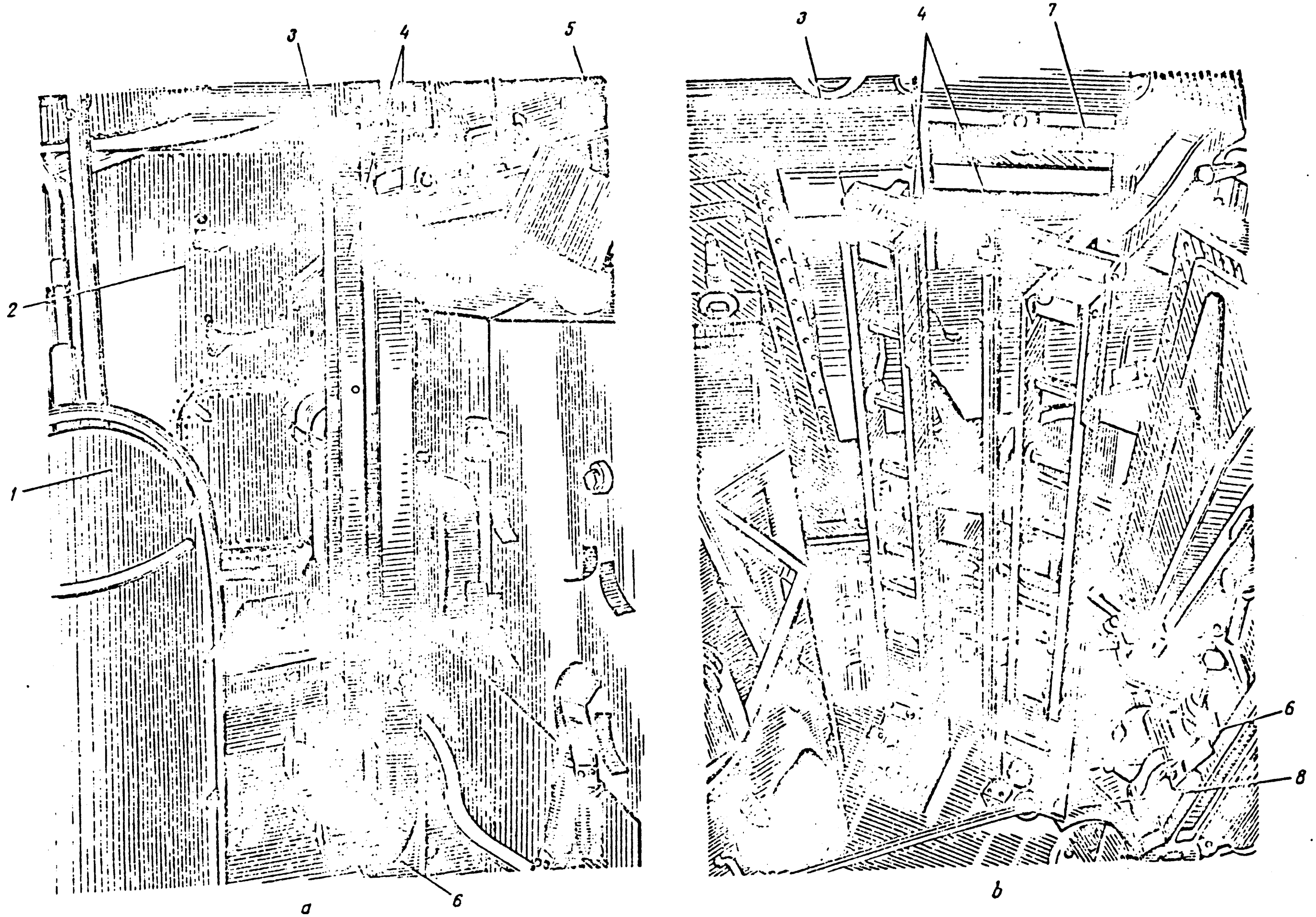

FIG.89: AT GUIDED MISSILE STOWAGE PLACE IN VEHICLE

a - stowage place on right side; b - stowage place in turret;
1 - guard; 2 - engine compartment bulkhead; 3 - guide rail retainer; 4 - guide rails; 5 - machine gun firing port; 6 - guide rail lower support; 7 - vision device; 8 - rotating floor of turret

[redacted]

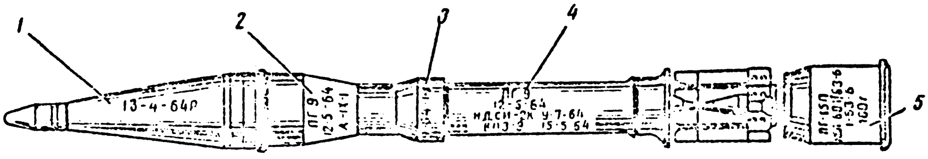
1
2
3
4
5
13-4-64P
ПГ9
12-5-64
А-IX-1
ПГ9
12-5-64
НДСН-2К 9-7-64
КПЗ-3 15-5-64

FIG.81. MARKING OF ROUNDS ПГ-15В

1 - code of manufacturing plant, lot No., year of manufacture; 2 - projectile symbol, No. of filling plant, year of filling; 3 - No. of projectile assembly lot and year of assembly; 4 - symbol of rocket motor, code of manufacturing plant, lot No., year of assembly, symbol of delay element; 5 - booster charge symbol; lot No., year of manufacture; mass of powder

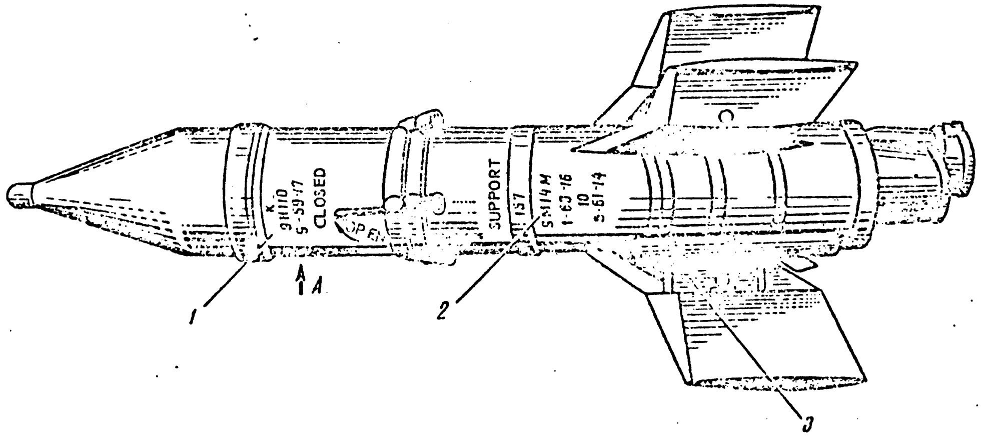
К
9Н110
5-59-7
CLOSED
OPEN
SUPPORT
157
9М14М
1-63-16
10
5-61-14
A
1
2
3

FIG.82 MARKING OF MISSILES 9M14M

1 - designation of warhead action, index of article, lot No., year of filling, code of manufacturing plant and code of explosive; 2 - missile index, lot No., year of manufacture, missile registration No., No. of assembly lot; 3 - tracer flare index; lot No., year of manufacture, code of manufacturing plants, fuze index, lot No. and year of manufacturm

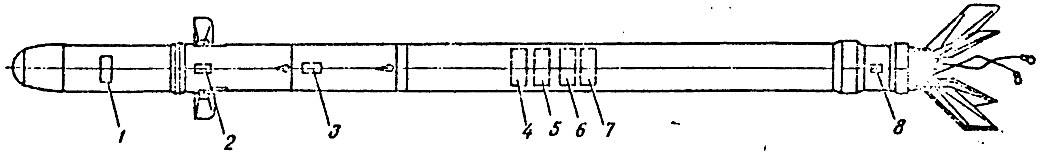

FIG.83 MARKINGOF ANTIAIRCRAFT MISSILE SYSTEM 9K32

1 - homing head index; 2, 3, 8 - missile registration No.; 4 - missile index; 5 - manufacture lot No. 6 - year of manufacture; 7 - filling lot No.

[redacted]

[redacted]

The ammunition allowance of the vehicle includes forty 9M14M for the ATGM launcher, two missiles for antiaircraft missile system 9K32, 2000 cartridge for coaxial machine gun ПКТ, 1800 cartridges for machine guns ПК, 10 hand grenades Ф1 and 12 signal flares.

3.8.2. Stowage

Forty rounds for the gun are arranged in the conveyer seats. Two antitank guided missile with the guide rails are located in the stowage places (Fig.80) arraged on the floor to the right of the operator, and two missiles are placed at the right side in the fighting compartment.

One antiaircraft missile of weapon system 9K32 with the launching mechanism and tube is placed in the troop compartment above the fuel tank, and the second missile is located at the right side in the fighting compartment.

2000 cartridges (loaded in belts) for machine gun ПКТ are placed in two ammunition boxes arranged under gun 2A28.

Six ammunition boxes of 200 cartridges each and four ammunition boxes of 100 cartridges each are arranged in the front part of the fighting compartment.

Hand grenades Ф-1 are placed in the box located on the rotating floor of the fighting compartment.

The signal flares in two bags are located on the left side of the driver's compartment.

3.8.3. Marking

The marking (signs and symbols) is applied to the ammunition so as to distinguish it and use only that ammunition which is intended for the given weapon.

The marking of the gun rounds is shown in Fig.81. Marked on round ПГ-15В are the followi components; the head, the projectile, the rocket motor and the booster charge.

The marking contains the following information: lot No., year of manufacture, projectile motor, retarder and booster charge codes, and the codes of the manufacturing plants.

Exemplary marking of missile 9M14M is shown in Fig.82. The marking of the antiaircraft missile of weapon system 9K32 is given in Fig.83.

[redacted]

4. LAYING DRIVES

4.1. GENERAL DESIGN

Laying of the armament mounted in the vehicle turret is carried out by means of laying drive 13Ц10М.

The electric pulse semiconductor drive provides for the following:

- transmission of a signal for automatic loading of the gun with setting of the gun to the loading angle;
- gun and coaxial machine gun fire control with clearance of spotlight ОУ-3ГА2 by the gun barrel while the turret is traversed.

The drive (Fig.84) comprises two drives, i.e. a traversing drive and an elevation dri composed in one unit.

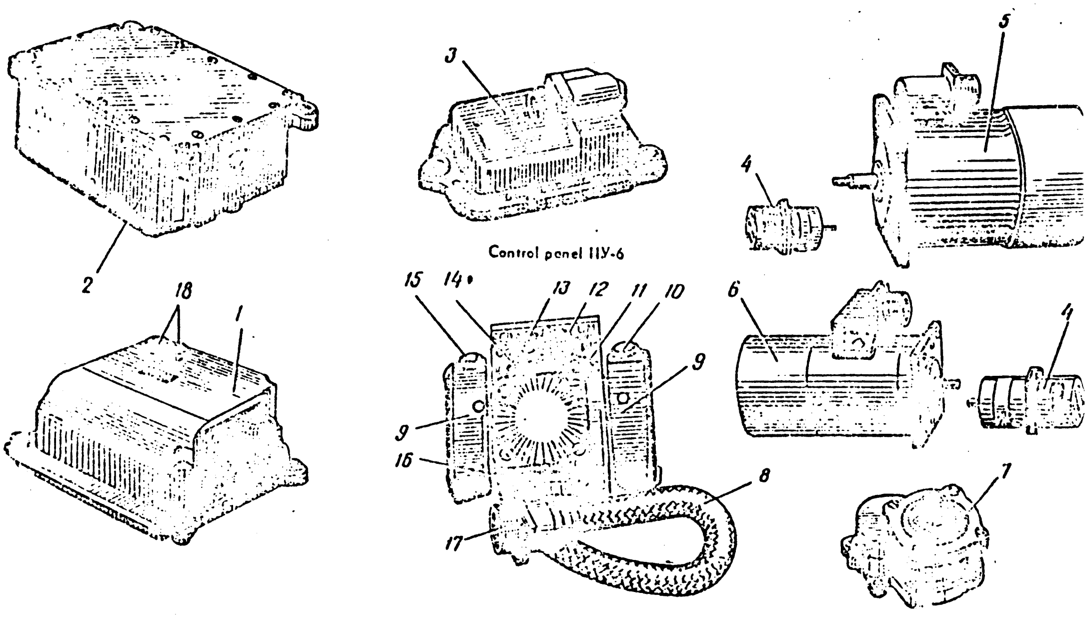

FIG.84. UNITS OF LAYING DRIVE 1ЭЦ10М

1 - relay box КР-6; 2 - triode box КТ-6; 3 - resistance box КС-5; 4 - tachogenerator ТГП-1; 5 - electric motor ДП-3; 6 - electric motor ДВН-1; 7 - setti evice ШП-5, 8 - shielded terminal; 9 - gun and coaxial machine gun control handles; 10 - gun firing button; 11, 14 - round-choice buttons (К - hollow chc C - fragmentation); 12 - loading mechanism switch LM (МЗ); 13 - laying drive switch DRIVE (ПРИВОД); 15 - machine gun firing button; 16 - flange with vertical turning axle; 17 - connector plug; 18 - plugs

[redacted]

- relay box 1 (KP-6);
- triode box 2 (KT-6);
- resistance box 3 (KC-5);
- setting device 7 (ПП-5);
- traversing electric motor 5 (ДГН-3) and elevation electric motor 6 (ДВП-1);
- two tachogenerators 4 (ТГП-1) of the elevation and traversing drives;
- a gun elevating mechanism and a turret traversing mechanism.

Besides, the drive electric circuit includes gun elevation and depression limiters, two danger zone limiters (right and left), a loading mechanism, an ABC protection system interlock, DRIVE ON signal lamps in the vehicle hull and turret, and auxiliary equipment.

Control panel ПУ-6 is designed for remote control of the laying drives. The panel is located in front of the operator. It is supported by ball bearings on a vertical axle whose flange 16 is secured by four bolts to a bracket attached to the turret race.

Arranged on the control panel are drive switch 13, round-choice buttons K and O (K - hollow charge, O - fragmentation), loading mechanism switch 12, gun firing button 10 and machine gun firing button 15.

The control panel consists of body 3 (Fig.85), a traversing drive potentiometer, elevation drive potentiometer 1, two handles 10, resistor plate 9, horizontal axle 2 and a vertic axle with a flange.

Handles 10 are secured on the horizontal axle, and the control panel body is mounted o the vertical axle flange. Installed on these axles are toothed sectors and cams. The cams ar slotted to accommodate the roller locking the panel and the knobs in the neutral position.

When control panel body 3 or handles 10 are turned the springs get compressed and the rollers come out of the slot. The maximum turning angles of the control panel and the handle are limited by limiting screws that stop the cams.

The toothed sectors mesh with the bevel gears fitted on the potentiometer axles. As the control panel or handles are turned the toothed sectors turn the potentiometer gears and together with them the axles and brushes of the slip rings, bringing about alteration of the resistance of the electric motors supply circuit and, thereby, the speed of the weapons lay

Relay box KP-6 (Fig.86) is designed for mounting of the following electric drive elemen relay 5, contactor 6, choke 4, semiconductor diodes and resistors 1. Provided on top of the body are two holes closed with plugs 18 (Fig.84). The holes are used when adjusting potentiometers ПП3-11 installed under them.

The relay box is located behind the triode box and is secured to the turret roof with bolts. Connection of the box to the electric drive circuit is effected by means of five plug connectors 8 (Fig.86).

Triode box KT-6 (Fig.87) is designed to accommodate triodes 3, diodes 5, polarized rel (РП-5), a transformer, resistor plate 4 and fuse plate 2.

The side wall of the triode box has two ports; one of them is intended for access to t fuses and the other one, to relay РП-5.

The triodes and diodes are secured directly to the body walls.

The box is connected with other elements of the electric drive by means of two plug connectors 8.

Resistance box KC-5 (Fig.88) accommodates the starting resistors.

Secured in the box with screws are two asbestos-cement plates 2 and 6 with nichrome wire resistors 5 and 4 placed between them in grooves.

The box is bolted to the turret roof on the left of the operator.

The setting device (Fig.89) serves to bring the gun to the loading angle.

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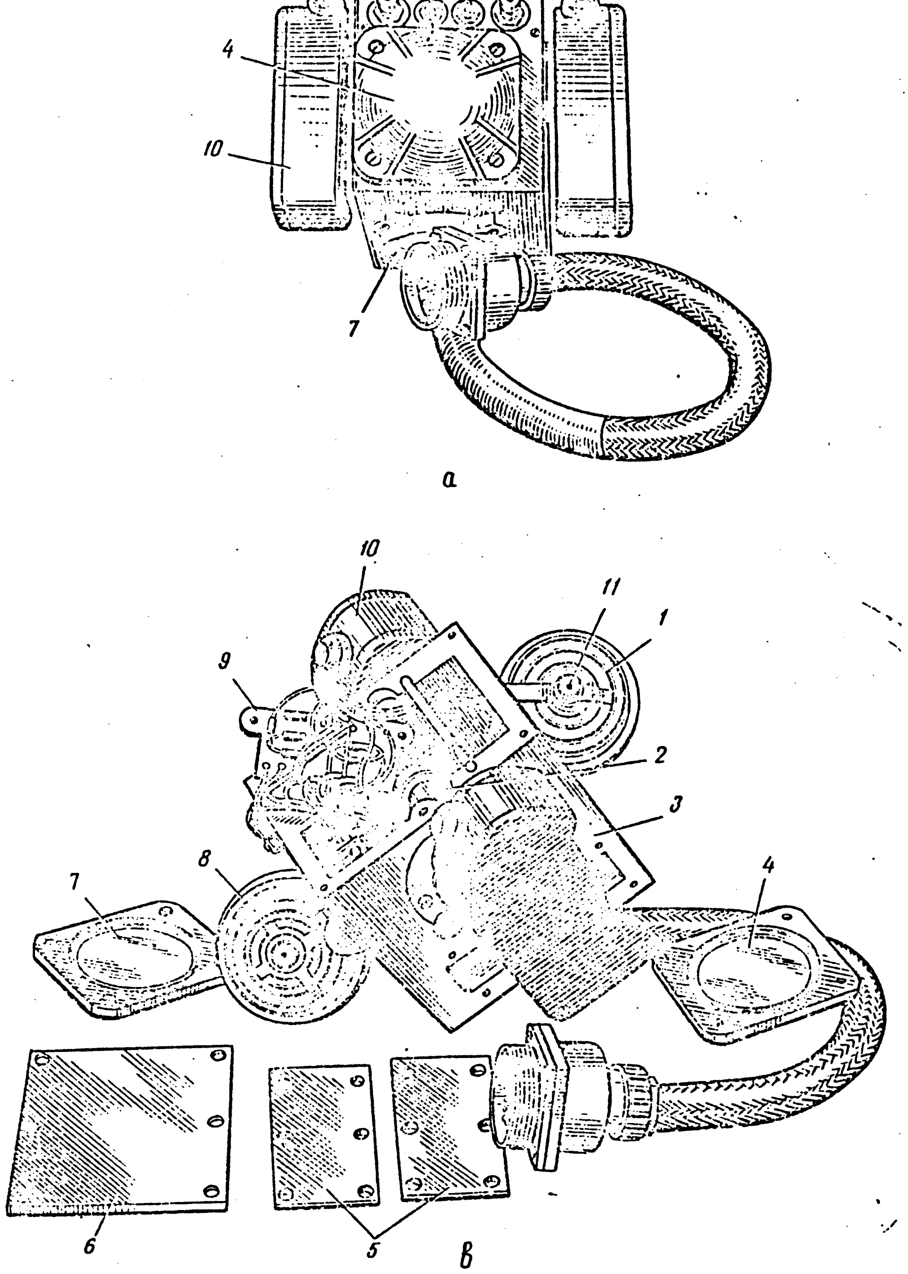

FIG.85. LAYING DRIVE CONTROL PANEL

a - general view; b - view with covers detached and potentiometets removed;
1 - elevation potentiometer; 2 - horizontal axle; 3 - control panel body; 4 - cover of elevation potentiometer; 5 - side covers; 6 - top cover; 7 - cover of traversing drive potentiometer; 8 - traversing drive potentiometer; 9 - resistor plate; 10 - control handles; 11 - bevel gear

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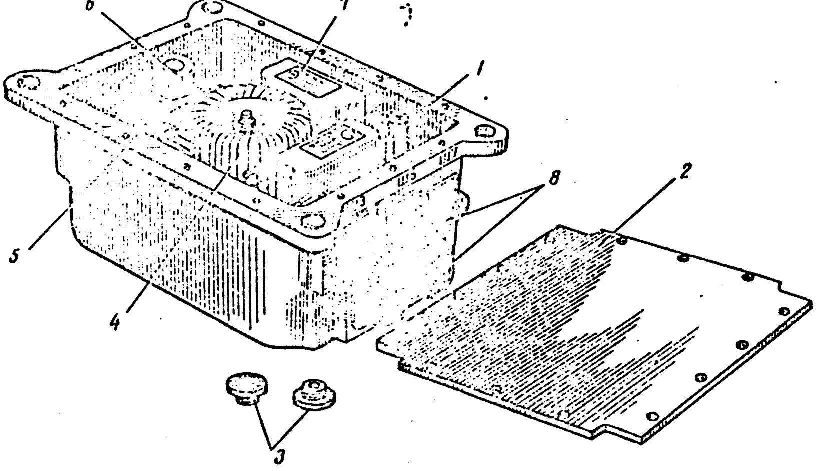

FIG.86. RELAY BOX KP-6 (COVER REMOVED)

1 - resistor ПЭВ; 2 - cover; 3 - plugs; 4 - choke; 5 - relay TKE-52ПД; 6 - contactor KM-50Д-B, 7 - relay 8Э11; 8 - plug connectors

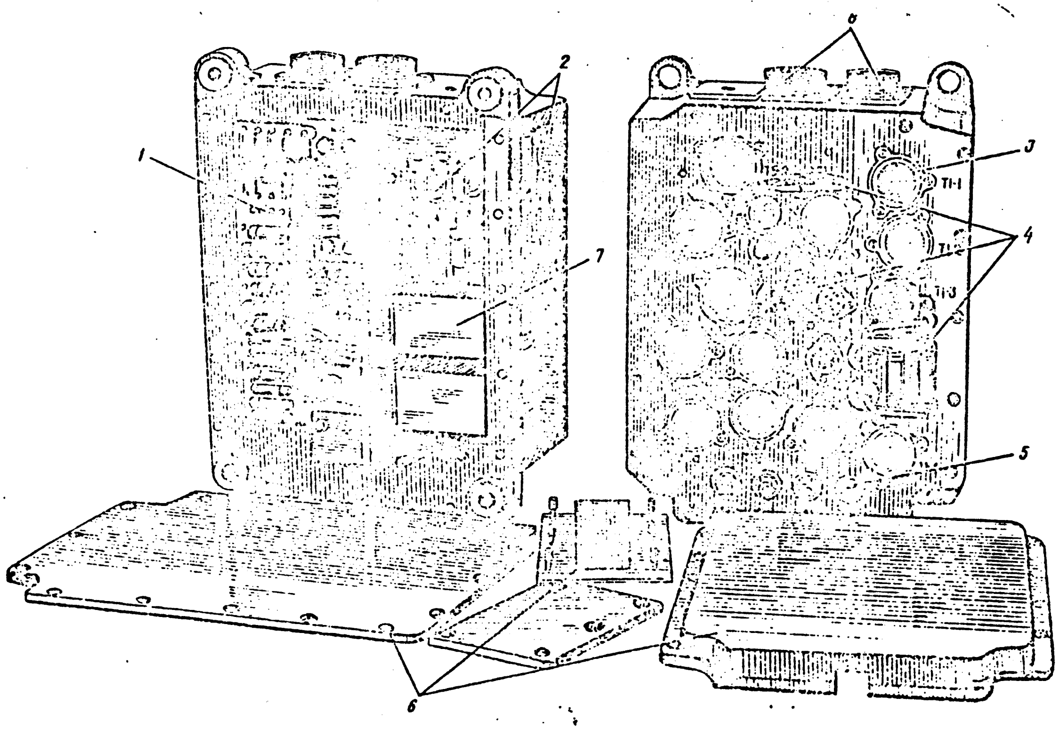

FIG.87. TRIODE BOX (COVERS REMOVED)

1 - removable panel; 2 - fuse plates; 3 - triode; 4 - resistor plates; 5 - diode; 6 - covers; 7 - polarized relay PII-5; 8 - plug connectors

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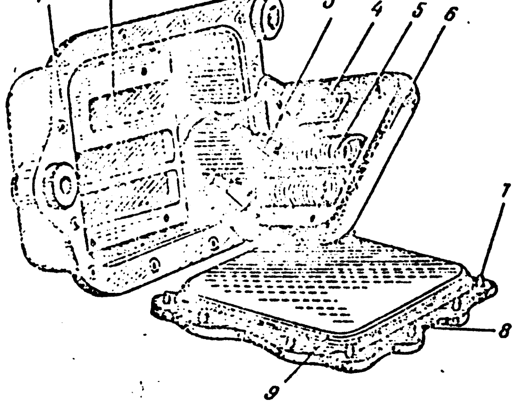

FIG.88. RESISTANCE BOX KC-5 (COVER REMOVED)

1 - body; 2, 6 - plates; 3 - nut; 4 - resistor R1; 5 - resistor R2; 7 - screw; 8 - cover; 9 - rubber gasket

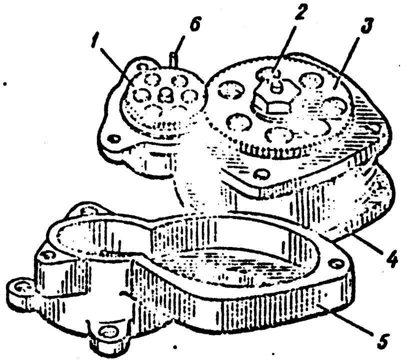

FIG.89. SETTING DEVICE ШП-5 (BODY PARTS DISCONNECTED)

1, 3 - gears; 2 - nut; 4, 5 - body parts; 6 - pin

It consists of detachable body parts 4 and 5, two gears 1 and 3, slip rings and brushes. Secured on small gear 1 is pin 6 to connect the setting device with the gun elevating mechanism.

Gears 1 and 3 are installed in slide bearings on axles secured in the body. Two brushes are fitted on the axle of large gear 3. Installed in the body are the slip rings, contact sectors and resistors. The brushes are in contact with the body slip rings.

The device is attached to the gun elevating mechanism and is kinematically connected to it by the pin.

Operation of the setting device consists in the following.

During operation of the gun elevating mechanism the setting device brushes (that are kinematically connected with it) move on the slip rings in correspondence with the gun position.

When button K of the control panel is pressed the relay incorporated in the gun loading mechanism circuit operates and switches over the vibration amplifier control windings from the control panel potentiometer slide to the setting device brush. The device brush slides upon the contact strip having three gaps. The middle gap corresponds to the loading angle, the other one is connected to the positive terminal and the third one to the negative terminal of the power source.

Thus, depending on the gun position and, consequently, on the brush position a control signal is sent to the elevating mechanism electric motor which brings the gun to the loading angle.

Traversing electric motor ДГН-3 is a DC motor with separate excitation. It is the actuating motor of the turret traversing drive.

The motor operates under frequent reversal conditions. Reversing is accomplished by changing the direction of the poles magnetic flux with permanent direction of current in the armature winding circuit. The armature speed is no less than 8000 r/m.

A resistor is included in the armature circuit for limiting the armature current during starting and reversal of the electric motor. The electric motor is mounted on the turret traversing mechanism.

[redacted]

with constant direction of the armature winding circuit current. Variation of the magnetic flux direction is effected by disconnecting voltage from the terminal of one series winding and connecting it to the terminal of the other series winding. During the motor operation one of the field windings is deenergized. The motor armature speed is no less than 4100 r/m. The motor is fastened to the gun elevating mechanism.

Tachogenerators ТГП-1 are designed to shape the armature speed feedback signals sent to the elevation and traversing drive circuit. The traversing drive tachogenerator is mounted on the turret traversing mechanism and is driven by gear 42 (Fig.91).

The elevation drive tachogenerator is attached to the gun elevating mechanism and is actuated by drive gear 22 (Fig.92).

The turret traversing mechanism is a mechanical reducer with electric and manual drives.

The mechanism is secured to the turret upper race 1 (Fig.90) by two supports 2 and 7. Rear hinged support 7 consists of a bracket attached by bolts 21 to the turret race, shaft 19 (with a head) fitted into eyes 16 of the bracket of support 7, and two bushings 18 installed in eye 17 of the traversing mechanism housing.

Front support 2 is elastic. It constantly presses output gear 16 (Fig.91) of the traversing mechanism to the toothed rim of the turret lower race. The support consists of a bracket of support 2 (Fig.90) fastened to the upper race by bolts 9, hinged bolt 12 secured by pin 15 in the eye of the bracket of support 2, bushing 13 and nut 14. Spring 11 thrusts against the bead of bushing 13 retained by nut 14, and presses eye 10 of the traversing mechanism housing to the turret race, thus ensuring reliable contact between the gear and the toothed rim.

The turret traversing mechanism consists of housing 13 (Fig.91) with electric motor 18 secured to its flanges, tubular housing 30, manual drive shaft 25 and tachogenerator 2. Installed inside the housing in ball bearings is a shaft made en bloc with worm 3.

Fitted over the shaft splined end is movable toothed coupling 40 which may be engaged with the internal teeth of bevel gear 42 driven by the electric motor, or with manual drive gear 39.

The coupling is controlled by button 23 which is screwed on the end of rod 24 passing inside shaft 25. The other end of the rod is joined with lever 38 which moves coupling 40 by means of a fork.

Fitted on the other end of the shaft of worm 3 are two thrust ball bearings 45. Placed between them is disc 46 taking up the reversing axial loads that act on the worm.

Shaft 7 made en bloc with cone 10 rotates in the housing lug in two ball bearings 14. The hub of the worm wheel meshed with the worm enters bearing 8, whereas the hub inner taper surface rests on cone 10 of shaft 7. Fitted on the shaft end is spring 6 pressing the worm wheel conical surface to the cone, thus ensuring transmission of torque from the worm to output gear 16 fitted on the splines of shaft 7. This transmission of the torque due to friction of the taper surfaces protects the mechanism from overload and plays the role of a safety coupling. The maximum moment of friction is adjusted by means of nut 5. Tachogenerator drive gear 49 is rotated by electric drive driven gear 42.

For traversing the turret by the electric drive, pull down button 23, thus engaging the teeth of coupling 40 with bevel gear 42. In this case, rotation is transmitted from electric motor 18 through gear 42 to the shaft of worm 3, worm wheel 9 and cone 10 to output gear 16. Tachogenerator 2 starts to rotate at the same time. ae.

Output gear 16 runs upon the fixed race toothed rim to make the traversing mechanism a thereby, the turret rotate on the ball support.

To shift over to the manual drive, press button 23 to engage toothed coupling 40 with bevel gear 39, thus connecting manual drive handwheel 27 with the output gear through hollow shaft 25, gears 34 and 39, toothed coupling 40 and further on as in the case of electric dri

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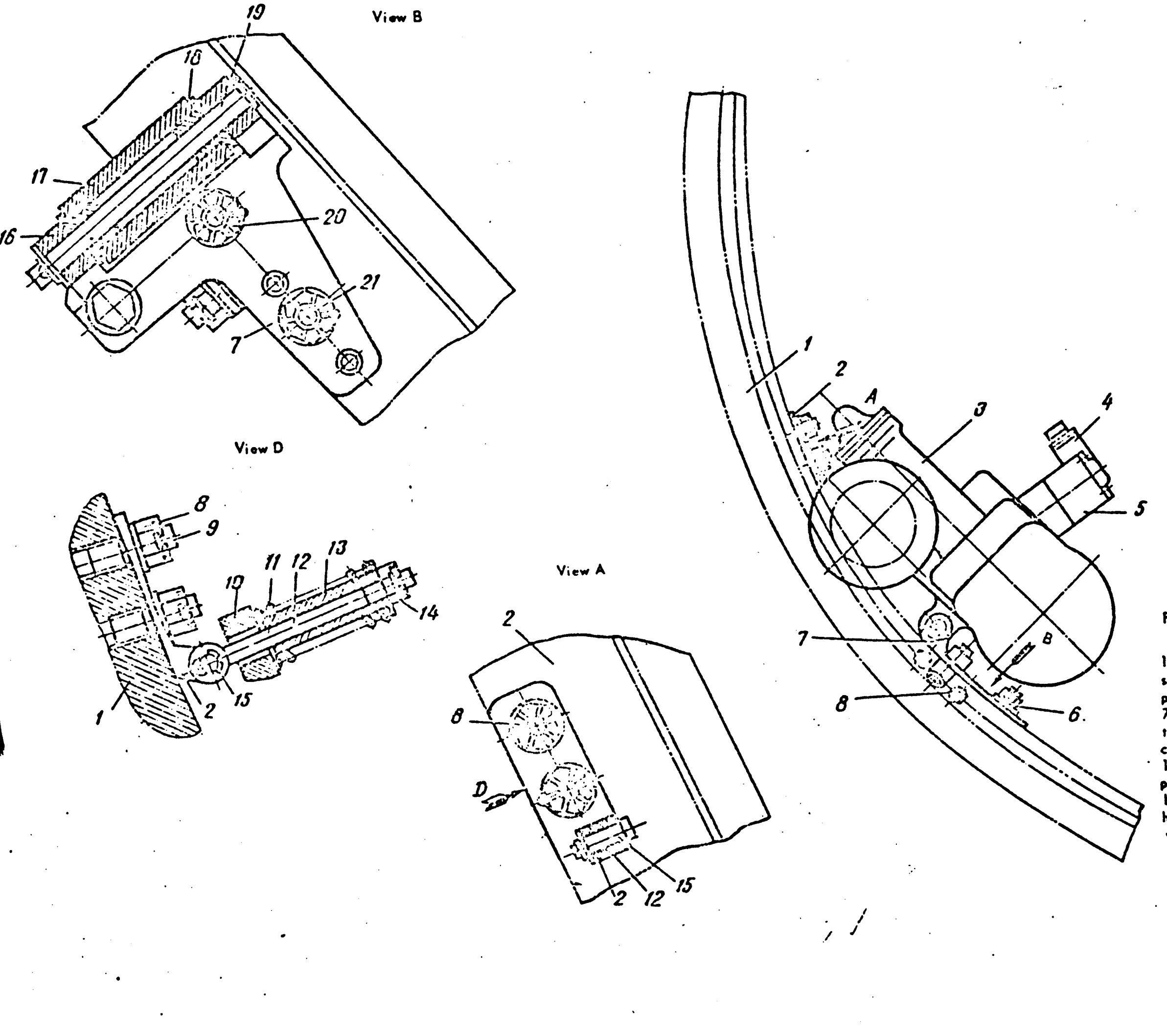
View B
19
18
17
16
20
21
7
View D
8
9
10
11
12
13
14
15
2
1
View A
2
8
D
2
12
15
1
2
A
3
4
5
7
8
B
6

FIG.90. FASTENING OF TURRET TRA
ING MECHANISM

1 - turret race; 2 - traversing mechanism
support; 3 - turret traversing mechanism
plug connector; 5 - tachogenerator; 6 -
7 - rear support; 8 - nut; 9 - front suppo
taching bolt; 10 - eye of turret traversin
chanism housing; 11 - elastic support s
12 - hinged bolt; 13 - bushing; 14 - elas
port nut; 15 - rear support pin; 16 - supp
bracket eye; 17 - eye of traversing mec
housing; 18 - rear support bushing; 19 -
with head; 20 - support fastening nut; 2
rear support fastening bolt

[redacted]

flanges, and tachogenerator 19.

Mounted inside the housing in two ball bearings is shaft 27 made en bloc with worm 14. Two thrust ball bearings 26 resting on supporting disc 29 are installed on the shaft end to take up the axial loads. Freely fitted on the other end of the shaft is gear 8 having intern teeth in its hub. Toothed coupling 7 is fitted on the splines of the shaft and may engage these teeth. Worm 14 is constantly meshed with worm wheel 10. Fitted over the shaft splines is output gear 13.

Installed in the lug of the housing is a shaft made en bloc with gear 6. Movable toothe coupling 7 may mesh with this gear.

The toothed coupling is shifted by means of fork 16 secured on shaft 30. Fitted on the shaft end is button 21 fixed by a lockpin.

Shaft 30 may be fixed in two positions by means of ball retainer 17 snapping into the shaft recesses.

Electric motor 15 is secured by bolts 31 to the housing flange, and the gear fitted on the motor armature is constantly meshed with gear 8.

Screwed on the other end of the shaft of worm wheel 10 is bushing 33 whose end has fork 32 with a slot to receive pin 6 (Fig.89) of setting device ПП-5.

The elevating mechanism is driven by the electric motor when toothed coupling 7 (Fig.92 is meshed with gear 8, for which purpose it is necessary to press button 21. Rotation is transmitted from the motor armature gear through cluster gear 23 and gear 6 to coupling 7, worm 14, worm wheel 10 and output gear 13. The output gear rolls on toothed sector 12 (Fig.42) secured on the gun mount to make the sector and, consequently, the gun move in vertical plane.

Simultaneously rotation is transmitted from cluster gear 23 (Fig.92) through intermedi gear 22 of the electric drive to gear 20 of the tachogenerator.

To engage the manual drive, pull button 21. As a result, toothed coupling 7 gets meshed with gear 6 and rotation is transmitted from handwheel 3 through gear 6 and toothed coupling to the worm and thence to the worm wheel and output gear.

4.2. PULSE CONTROL PRINCIPLE

The electric drive employs the pulse principle of controlling the speed of the turret traversing and gun elevation electric motors.

The essence of this principle consists in periodic alteration of the circuit of the electric motor connection to the vehicle mains, i.e. the motor is connected to the mains either directly or through a resistor.

When the electric motor is connected without a resistor it generates a positive torque and this period is referred to as "acceleration". The second part of the cycle (when the motor is supplied through a resistor) is called "braking". The motor speed is controlled by varying the time relationship between "acceleration" and "braking" (the on-off time ratio).

Used in the drive as switching elements are semiconductor triodes (transistors) which accomplish pulse control. The triodes are practically inertialess and control-free.

The triode is a semiconductor device operating as an automatic switch. It consists of base (plate) 4 (Fig.93), cut out of a germanium single crystal, with atoms of arsenic, antimony, indium and other admixtures introduced in its crystal lattice. The base plate is treated from both sides by the admixtures and has three areas of different conductivity: the two extreme areas have "hole-type" conductivity, i.e. current is carried in these areas by positive ions ("holes"), and the middle area has electronic conductivity. The germanium plate is placed in metal bulb 1 welded to metal flange 7. According to the purpose of the

[redacted] [redacted]

Inset 5

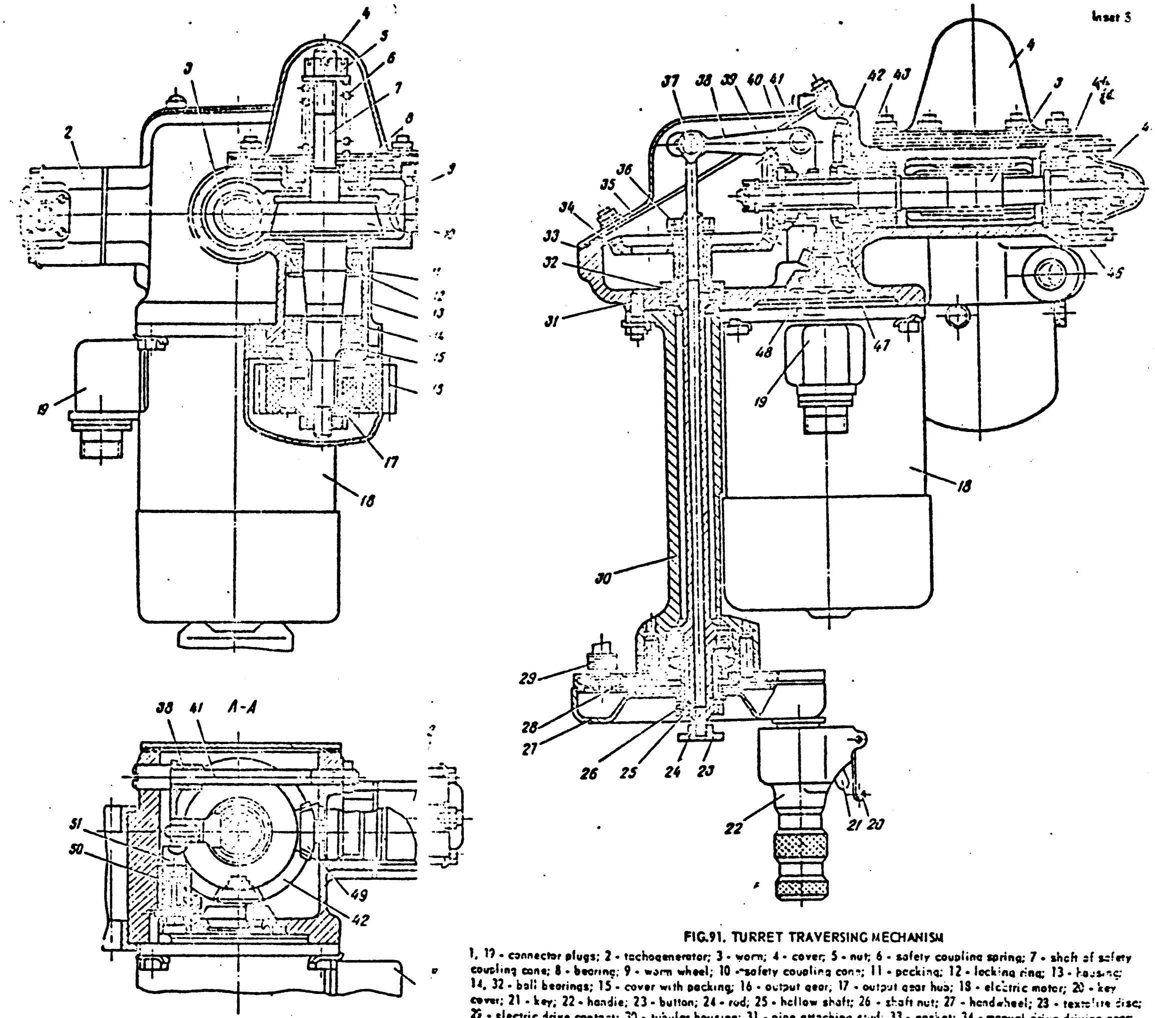
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FIG.91. TURRET TRAVERSING MECHANISM

1, 19 - connector plugs; 2 - tachogenerator; 3 - worm; 4 - cover; 5 - nut; 6 - safety coupling spring; 7 - shaft of safety coupling cone; 8 - bearing; 9 - worm wheel; 10 - safety coupling cone; 11 - packing; 12 - locking ring; 13 - housing; 14, 32 - ball bearings; 15 - cover with packing; 16 - output gear; 17 - output gear hub; 18 - electric motor; 20 - key cover; 21 - key; 22 - handle; 23 - button; 24 - rod; 25 - hollow shaft; 26 - shaft nut; 27 - handwheel; 28 - textolite disc; 29 - electric drive contact; 30 - tubular housing; 31 - pipe attaching stud; 33 - gasket; 34 - manual drive driving gear; 35 - cover; 36 - hollow shaft attaching nut; 37, 41 - axles; 38 - drive engagement mechanism lever; 39 - manual drive driven gear; 40 - drive engagement coupling; 42 - electric drive driven gear; 43 - packing; 44 - worm shaft bearing; 45 - worm thrust bearing; 46 - thrust disc; 47 - electric drive driving gear; 48 - electric motor shaft; 49 - tachogenerator gear; 50 - spring; 51 - retainer

[redacted] [redacted]

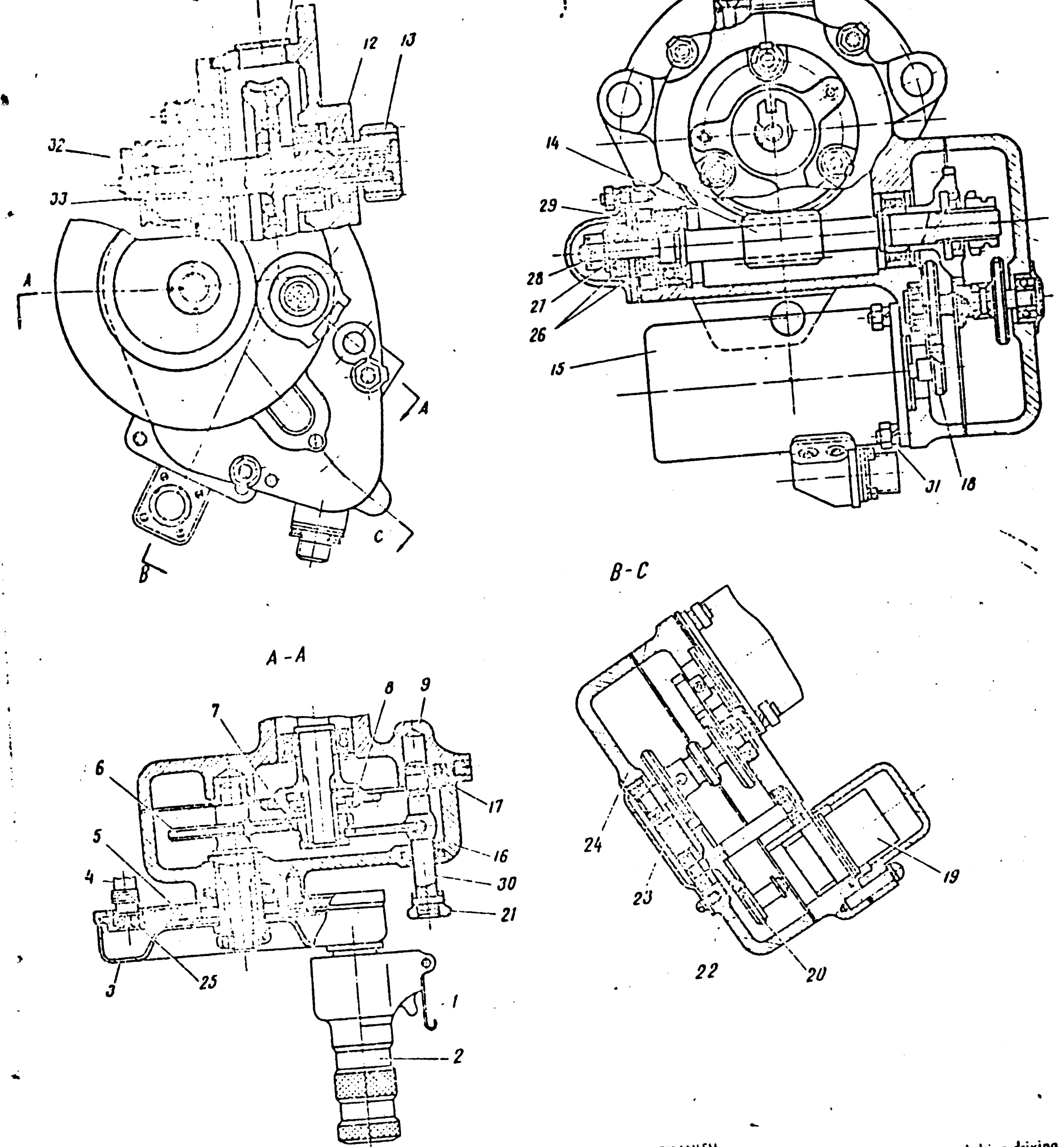


FIG.92. GUN ELEVATING MECHANISM

1 - key cover; 2 - manual drive handle, 3 - manual drive handwheel; 4 - electric cable; 5 - textolite discs with slip rings,6 - manual drive driving gear; 7 - drive engagement toothed coupling; 8 - electric drive driven gear; 9 - mechanism housing; 10 - worm wheel; 11 - flange; 12 - packing; 13 - output gear; 14 - worm; 15 - electric motor; 16 - drive engagement fork; 17 - retainer ball; 18 - electric drive driving gear; 19 - tachogenerator; 20 - tachogenerator drive gear; 21 - button of drive engagement mechanism rod; 22 - intermediate gear; 23 - intermediate cluster gear; 24 - housing cover; 25 - slip ring; 26 - thrust bearings; 27 - worm shaft; 28 - nut; 29 - supporting disc; 30 - fork shaft; 31 - electric motor attaching bolts; 32 - setting device drive fork; 33 - bushing

[redacted]

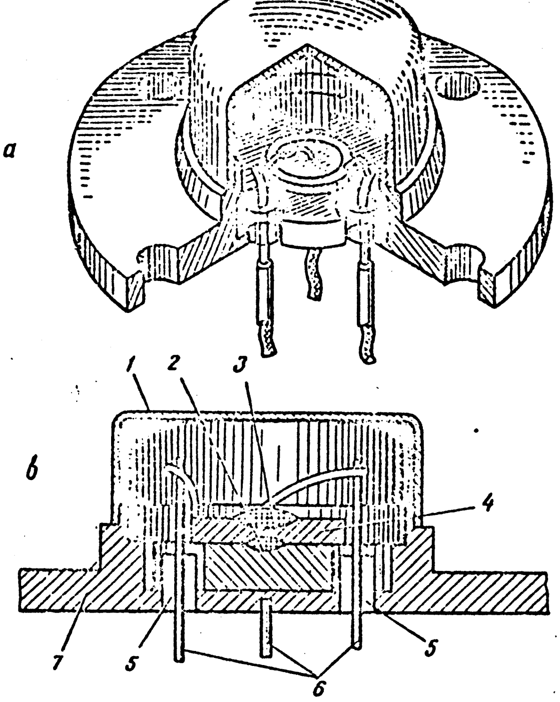


FIG.93 CRYSTAL TRIODE П4Б

a - general view; b - schematic view;
1 - bulb; 2 - collector; 3 - emitter; 4 - base; 5 - insulators; 6 - leads;
7 - flange

emitting the current carriers), collec (the area collecting the current carri and base (the middle area). The triode a property of changing its conductivit the emitter-collector direction when v is applied between the emitter and the

If the positive potential is ap to the emitter and the negative one, t the base, current goes through the tri crystal from the emitter to the collec (the triode is conductive). If the pol is reversed, the triode is cut off and current flows in emitter - collector c

Shown below in Fig.94 is the conn tion diagram of a semiconductor triode

When the triode is connected to t circuit its resistance between the emi (E) and collector (C) varies within wi limits depending on the signal at the i.e. base current I_b. When the triode conductive this resistance amounts to hundredth fractions of an ohm, and whe triode is cut off it reaches several thousand ohms.

At a cut-off triode the resistanc between the emitter and collector cons rably exceeds the load resistance. The voltage drop at the triode is so large the load appears to be disconnected fr the power source, i.e. the electric mo is deenergized.

At a conductive triode the voltage drop is insignificant and almost the whole mains voltage is applied to the electric motor.

A change in the value and polarity of control voltage U_e causes variation of the vol drop value and current I_1 in the circuit of load R_1 (electric motor) connected in series the triode.

In case of instantaneous change of the signal at the triode input the change-over of triode from the cut-off to conductive state and vice versa occurs during ten thousandth fractions of a second. This operating condition of the triode is called the key mode.

In the key mode of operation at the moment of a triode cut-off there appears a consi able self-induction voltage in the circuit that may render the triodes unserviceable. A diode is switched in parallel to the electric motor armature to protect the triodes.

The traversing drive motor is controlled by six parallel-connected triodes, while th elevation drive motor is controlled by three parallel-connected triodes.

4.3. OPERATION OF LAYING DRIVE

4.3.1. General

The schematic general diagram of the electric drive is given in Fig.95. The followin symbols are used in this diagram: the initial letters of the symbol stand for an abbrevia designation of the device, the letter preceded by a dash designates the device element, t figure indicated its ordinal number.

[redacted]

For example, KP-P10 means: relay P No.10 of relay box KP.

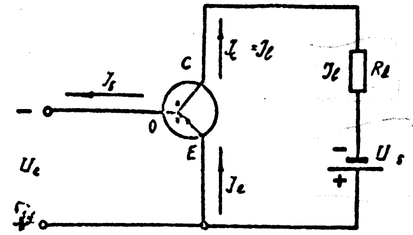
4.3.2. Operation of Elevation Drive

Prior to switching on the electric drive, it is necessary to unlock the gun and change over the elevating mechanism for operation from the electric drive.

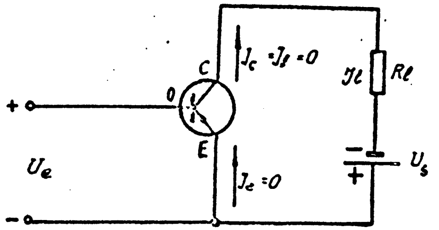
To switch on the drive, turn on tumbler switch ПУ-В (DRIVE) on the control panel. When the switch is at ON, four signal lamps marked DRIVE (ПРИВОД) must light up (two of them are located in the troop compartment, one on driver's central panel and one on the operator's control panel).

When the switch is turned on, relay KP-17 operates and contacts KP-P7 (10-20) get closed to complete the following circuit: the power source positive terminal, slip ring ВКУ-1, fuse Пр-1, closed contacts 10-20 of relay P-17, diode KT-Д2, resistor KP-R2, slip ring ВКУ-1 and the negative terminal of the power source.

A direct drop of voltage across diode KT-Д2 is fed through resistors KT-R5 and KT-R6 and fuses KT-Пр2 and KT-Пр3 to the emitter-base junction of parallel-connected triodes KT-T3 and KT-T5.



Triode conductive



Triode cut-off

FIG.94. CONNECTION DIAGRAM OF SEMICONDUCTOR TRIODE WITH COMMON EMITTER

U_s - supply voltage; U_e - control voltage; R_l - load

As a result, the potential of the triode base becomes higher than that of the emitters by the value of the direct voltage drop across diode KT-Д2. Therefore triodes KT-T3 and KT-T5 are closed, the resistance between the emitter and collector is at its maximum and all the supply voltage is applied to the triodes. The triode bases are connected through resistors KT-R4 and KT-R7 with the positive terminal of the power source, therefore triodes KT-T4 and KT-T are also cut off. Due to this the electric motor is not switched on.

To switch on the electric motor, it is necessary to turn the control panel handles. The speed of the gun elevation or depression is changed by turning the control handles through the corresponding angle: the greater the angle of turn, the faster the speed. Turning of handles switches on the control current which ensures pulse control.

An oscillating amplifier is included in the electric drive circuit to change the duty ratio (the ratio between the acceleration and braking periods). Used as the oscillating amplifier is highly sensitive polarized relay 7 (Fig.87), type РП-5 KT-P2, located in the triode box.

The oscillating amplifier (Fig.96) has a contact group, consisting of two fixed contacts Л and П and movable armature Я. Power is supplied to the fixed contacts through resistors KT-R10 and KT-R11 (Fig.95). The contacts are connected with triodes KT-Д4 and KT-Д6 and the movable armature, with the power source negative terminal.-

As armature Я (Fig.96) is touches contact Л (contact group KT-P2) the negative potential of the power source is fed through resistor KT-R10 (Fig.95) limiting the base current to the base of triode KT-T4.

The potential of the composite triode base becomes less than the emitter potential and triode KT-T4 becomes conductive to simultaneously make triodes KT-T3 conductive too. The resistance between the emitter and collector of triodes KT-T3 becomes minimum and the power source voltage is almost completely applied to electric motor M1. The circuit formed here is as follows: the power source positive terminal, slip ring ВКУ-1, fuse Пр1, contacts KP-P7 (10-20), diode KT-Д2, triode KT-T3, bias resistor of composite triode KT-TP (6-2), field winding M1-OB, the armature of electric motor M1 and the negative terminal of the power sourc

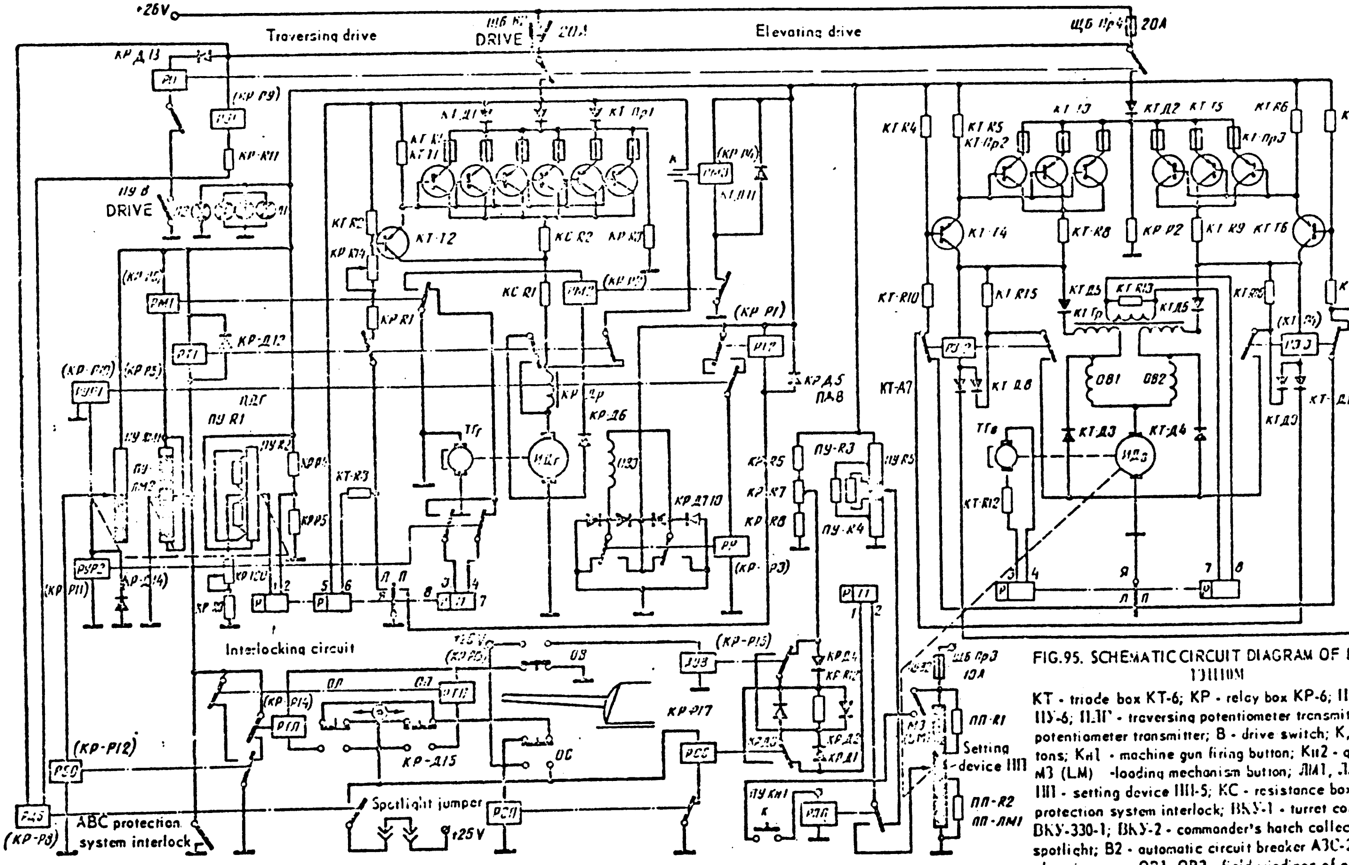

+26V
Traversing drive
Elevating drive
ЩБ Пр4 20А
DRIVE
КР Д13
ПУ В
DRIVE
Interlocking circuit
Spotlight jumper
+25V
ABC protection
system interlock
(КР-Р8)
(КР-Р12)
КР-Д15
ОП
ОЛ
ОВ
ОС
КР-Р17
КТ-А7
КТ-Д10
ИДв
ИДг
ТГг
ТГв
ОВ1
ОВ2
ПУ-R3
ПУ-К4
ПУ R1
ПДГ
КР-Д6
КР-Д10
ЩБ Пр3 10А
ПП-R1
Setting
device ПП
ПП-R2
ПП-ДМ1
ПУ КН1
Л П
Я

FIG.95. SCHEMATIC CIRCUIT DIAGRAM OF ELECTRIC DRIV
ЭШ0М

КТ - triode box КТ-6; КР - relay box КР-6; ПУ - control panel ПУ-6; ПДГ - traversing potentiometer transmitter; ПДв - eleva potentiometer transmitter; В - drive switch; К, О - gun loading tons; Кп1 - machine gun firing button; Кп2 - gun firing button; МЗ (LM) -loading mechanism button; ДМ1, ДМ2 - contact strip ПП - setting device ПП-5; КС - resistance box КС-5; БЛ - ABC protection system interlock; ВКУ-1 - turret collector ring box ВКУ-330-1; ВКУ-2 - commander's hatch collector ring box; ОУ- spotlight; В2 - automatic circuit breaker АЗС-25;ИДв - elevation electric motor; ОВ1, ОВ2 - field windings of elevation electric motor; ИДг - traversing electric motor; ОВг - field winding of traversing electric motor; ТГв - elevation drive tachogenerator ТГП-1; ТГг - traversing drive tachogenerator ТГП-1; ОВ - gun elevation limiter; ОС - gun depression limiter; ОП - gun clockwi traverse limiter; ОЛ - gun counterclockwise traverse limiter

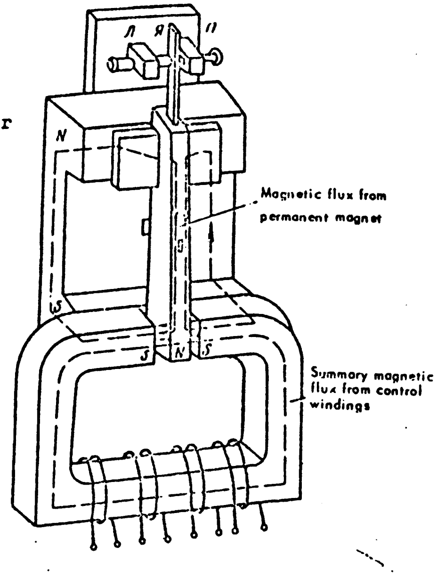
As armature Я is off contact Л composite triode KT-T4, KT-T3 is cut off and the supply voltage is removed from the electric motor.

As armature Я is at contact П, the composite triode consisting of triodes KT-T6 and KT-T5 becomes conductive and to complete the following electric circuit: the power source positive terminal (+26 V), slip ring BKУ-1, fuse Пр1, KP-P7 (10-20), KT-Д2, KT-Пр3, KT-T5, bias resistor KT-R9, diode KT-Д6, receptacle of transformer KT-Tp (1-5), field winding M1-OB, the armature of motor M1 and the power source negative terminal.

In this case motor M1 rotates in the opposite direction under the action of the applied voltage.

To ensure the motor operation without perceptible speed pulsation due to alternating periods of acceleration and braking, the armature is made vibrating relative to one of contacts Л or П with high frequency. This is attained by employing a circuit consisting of tachogenerator Tp1, winding KT-P2 (3-4), polarized relay PП-5 and resistor KT-R12.

The tachogenerator is a DC generator with excitation from a permanent magnet. Being driven by the elevating mechanism reducer, the tachogenerator generates DC voltage, which is directly proportional to the motor armature speed. The voltage polarity depends on the sense of rotation armature.


Л
Я
П
N
S
S
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Magnetic flux from permanent magnet
Summary magnetic flux from control windings

FIG.96. OSCILLATING AMPLIFIER (SCHEMATIC VIEW)

The operating principle of the oscillating amplifier consists in the following. When DC voltage is fed from the control panel to control windings KT-P2 (1-2) and KT-P2 (6-5) of the oscillating amplifier, armature Я is brought to contact Л or П. Motor M1 starts rotating under the action of the power source voltage applied to it, and the tachogenerator starts generating a voltage proportional to its speed.

Oscillating amplifier winding KT-R2 (3-4) is connected so that the magnetic flux created there by the tachogenerator current is directed opposite to the flux of the control windings. Closed condition of armature Я is retained until the summary magnetic flux becomes close or equal to zero. When the armature is disconnected, the motor speed slows down, the current generated by the tachogenerator is reduced, and the armature gets closed again, i.e. an oscillating mode of the polarized relay armature operation is created.

To ensure uniform speed of the electric motor, the circuit is provided with a negative feedback according to the variation of the electric motor load current. It is ensured by oscillating amplifier winding KT-P2 (7-8) and the secondary winding of transformer KT-Tp (3-4) shunted by resistor KT-R13.

Thus, relay PП-5 has four windings. Two of them are control windings, one is a speed feedback winding and the fourth one is an electric motor load current variation feedback winding.

The oscillating condition of armature Я is determined by joint action of the four windings. The time of closed state of the armature depends on the value of the control voltage fed to the control windings. The greater the control voltage, the longer the time.

The motor rotation voltage depends on which of the fixed contacts is closed with armature "Я".

The control voltage is shaped by potentiometer ПУ-R5 which is coupled with the control panel handles.

[redacted]

Turning the control panel handles causes displacement of the slide of potentiometer ПУ-R5. The potentiometer slide potential may be more or less than the potential of the middle point of the divider consisting of resistors КР-R6, КР-R7 and КР-R8. If it is grea current will flow from the slide to the divider through windings КТ-Р2 (1-2) and КТ-Р2 (6 if it is less current flows in the opposite direction. Depending on the direction and val of the current flowing in the oscillating amplifier control windings the direction and sp of rotation of electric motor M1 are varied, and thus the speed and direction of gun moti in vertical plane. Pulling the control handles elevates the gun, pushing the handles depr it. The greater the angle of the handles turn, the greater the speed of the gun motion.

4.3.3. Operation of Gun Elevation and Depression Limiters

When the gun approaches the maximum angle of elevation limit switch OB (elevation li functions to energize relay КР-Р15.

Contacts 3-5 in the relay close and voltage is supplied to diode КР-Д4 to meet the voltage fed from control windings КТ-Р2 (1-2) and КТ-Р2 (6-5).

Due to the feedback the oscillating amplifier armature is switched over to the oppos fixed contact and brings motor M1 into plugging up to complete stoppage.

Gun release from the limiter is performed by shifting the control panel handles in t opposite direction from the neutral position.

This action connects diode КР-Д4 so that current flows in the control windings, whi releases the gun from the limiter.

At maximum depression of the gun, limit switch OC (depression limiter) operates, its contacts are closed and current passes through them and normally-closed contacts КР-Р16 t cuts off relay КР-Р16 and energizes relay КР-Р17. Contacts 3-4 of relay КР-Р17 break and contacts 3-5 get closed. As a result, diode КР-Д1 is switched on opposite to the directio the current of control windings КТ-Р2 (1-2) and КТ-Р2 (6-5), and the electric motor is braked as in case of operation of the elevation limiter.

4.3.4. Operation of Loading Angle Setting System

As button K is pressed on the control panel the loading mechanism relay is energized This relay switches over control windings КТ-Р2 (1-2) and КТ-Р2 (6-5) of the oscillating amplifier from the slide of control panel potentiometer ПУ-R5 to the setting device brush

If at this moment the gun is elevated to an angle exceeding the loading angle, the t to which current is supplied is located on the section of setting device contact strip Ш which is connected with the negative terminal of the power source.

As the brush potential is less than the potential of the middle point of the divide (resistors КР-R6, КР-R7 and КР-R8), the current goes through the oscillating amplifier c windings from the divider middle point to the setting device brush. This control current induces electromagnetic field that closes the armature to the fixed contact of the oscil amplifier, motor M1 is started and the gun is brought to the loading angle.

When the gun approaches the loading angle the negative potential of the power sourc brought to the setting device brushes through resistor ШП-R2, which provides for slowing down of the gun motion.

If the gun is depressed when button K is pressed the setting device brush is at the section of the contact strip, which is connected with the positive terminal of the power source. As the brush potential is higher than the potential of the divider middle point, current flows through the oscillating amplifier control windings in the opposite directi (as compared with the case described above) and the direction of the gun motion is rever

When control panel button O is pressed the loading mechanism relay operates in the way as in the case of pressing button K, and the gun is set at the loading angle.

[redacted]

The speed of traverse is changed similarly to the case of the elevation drive, i.e. altering the mean value of the voltage supplied to the motor.

Used in the traversing drive is an electric motor with separate excitation, which lea to a change in the electric drive circuit. Therefore this circuit employs only one group o parallel-connected triodes. They function in the key mode to vary the value of the mean voltage supplied to the electric motor armature.

The motor is reversed by changing the polarity of the voltage supplied to the field windings.

The duty ratio of the control signal is varied by means of polarized relay KT-P1 whic also has four windings of the same purpose as those in relay KT-P5.

The principle of control voltage shaping is similar to that described for the elevat drive.

The difference lies in the fact that the voltage of potentiometer ПУ-R2 delivered to the polarized relay control winding is of one and the same polarity whatever the directio the control panel turn. Only the control voltage is varied, increasing proportionally to angle of turn of the panel body from the neutral position. The greater the angle of turn, the greater the speed of turret traverse. When the panel is turned to bear against the st the speed of turret traverse jumps from the maximum speed of 5 deg/s up to the slew speed 20 deg/s. Given below is a brief description of the circuit functioning.

Turning the control panel relative to the vertical axis moves three slides of the control panel traversing potentiometer secured on one axle, namely those of contact strip ПУ-ЛМ1, contact strip ПУ-ЛМ2 and potentiometer ПУ-R2.

Described below is the control panel turn to the left, in which case slide ПУ-ЛМ1 mc over an insulated section. When slide ПУ-ЛМ2 leaves the middle contact zone to get onto t insulated section relay KP-P5 is deenergized, contacts KP-P5 (11-21) and KP-P5 (13-23) ai closed and contacts KP-P5 (12-22) break.

The oscillating amplifier control winding (1-2) is connected between the slide of po tiometer ПУ-R2 and the middle point of the voltage divider consisting of resistors KP-R4 KP-R5. Both arms of potentiometer ПУ-R2 are connected with the positive terminal of the power source, therefore when the control panel body is turned in any direction from the r position the potential at the slide is always higher than that at the divider middle poir current passing through winding KT-P1 (1-2) oscillat

Under the action of the control current passing through winding KT-P1 (1-2) oscillat amplifier armature Я is brought against fixed contact Л. Due to the speed and load feedb the armature starts to oscillate.

Closing of the armature forms the following circuit: the power source positive term slip ring BKY-1, fuse Пр2, closed contacts KP-P7 (12-22), diodes KT-Д1, fuses KT-Пр1, triodes KT-T1, bias resistor of composite triode KC-R1, limit resistor KC-R2, choke KP-Д the armature of electric motor M2, slip ring BKY-1 and the negative terminal of the power source.

The speed of motor M2 is proportional to the mean value of the voltage applied to t motor armature, which depends on the duty ratio of the key-type operation of composite triode KT-T1, KT-T2.

To maintain a continuous load current under the pulse control condition, used in th traversing drive circuit is choke KP-Др which increases inductivity of the circuit of th armature of motor M2.

When the slide of potentiometer ПУ-R2 is shifted farther from the neutral position armature speed increases, and when the slide of contact strip ПУ-ЛМ2 comes to the extrem contact zone relay KP-P6 operates. In this case contacts KP-P6 (4-3) break and contacts KP-P6 (3-5) get closed, which leads to disconnection of windings KT-P1 (3-4) and KT-P1 (8-7) from tachogenerator TГ2, i.e. to disconnection of the motor speed feedback and to connection of relay KP-P2 (contacts 3-5) in parallel with the motor armature.

[redacted]

brought to contact Л, composite triode KT-T1, KT-T2 becom conductive and the power source voltage is applied through resistor KC-R2 to the electric armature which starts to accelerate. As the armature gains speed the electromotive force induced in the armature increases. When it reaches a value of 14 to 18 V, relay KP-P2 ope and its contacts KP-P2 (3-5) connects the power source negative terminal to the winding c contactor KP-P4. The contactor operates.

The following electric circuit is formed: the power source positive terminal (+26 V), slip ring BKУ-1, fuse Пр2, contacts KP-P7 (12-22), closed contacts KP-P4, normally-closec contacts KP-P5 (13-23), choke KP-Др, the armature of motor M2, slip ring BKУ-1 and the negative terminal of the power source.

As the choke active resistance is insignificant, the motor armature is energized wit full voltage by-passing the composite triode. Thus, the speed of turret traverse abruptly changes from the maximum to the slew value.

Operation of the traversing drive when the control panel is turned in the opposite d tion is similar to that described above. But in this case the polarity of the field windi is reversed.

Field winding M2-OB of the electric motor is connected to the power source through normally-closed contacts KP-P3 (4-5) and KP-P3 (2-1).

In case of decreasing control signal from the control panel electric motor M2 is dyn mically braked also by reversing the polarity of the field winding connection when armatu touches oscillating amplifier fixed contact П.

The polarity at the windings is reversed by switching over the contacts of relay KP and cutting off relay KP-P3.

During the traversing drive operation there may happen an operating condition charac rized by braked electric motor armature in case the turret traverse meets considerable resistance. In this case, due to the absence of the speed feedback (the tachogenerator is motionless) oscillating amplifier armature Я is brought to fixed contact Л and does not c to the oscillating duty. The value of the short-circuit current in the armature circuit i determined basically by the sum of the active resistances of the armature, choke KP-Др an resistor KC-R2.

As relay KP-P6 operates when energized through the slide and the extreme contact zon of contact strip ПУ-ЛП2, relay KP-P2 is not switched on through closed contacts KP-P6 (3-5) because its operating voltage exceeds the voltage drop at the armature and choke KP As a result, the armature is connected to the power source not directly, but only through composite triode KT-T1, KT-T2. The value of resistance of resistor KC-R2 is chosen procee from the permissible value of the composite triode current, which prevents failure of the circuit elements.

The traversing drive is provided with an interlock which functions in case of operat of the overall protection system. For this purpose the protection system circuit include relay whose contacts close when the system operates. Closing of the contacts leads to operation of laying drive relay KP-P5. As a result, the electric motor stops irrespective the control panel position.

When spotlight ОУ-3ГА2 is installed on the turret the gun barrel may strike it while turret traverses. To prevent it, the traversing drive has two limit switches located on t right (switch ОП) and left side (switch ОС). When the turret is traversed by the drive an gun approaches the spotlight from any side, the traversing drive electric motor is switche and the turret stops automatically. To pass the dangerous zone, the gun must be elevated the maximum angle.

When the gun barrel is above the dangerous zone, the elevation drive is inoperative the system for setting the gun at the loading angle is cut off.

[redacted]

are of the laying drive consists in the following:

- regular checking of smooth acceleration of the turret traverse and gun elevation (depression);
- checking of the limit switches, spotlight clearance zone system, loading angle settin system and ABC protection system interlock for proper operation;
- checking of the circuit elements for proper fastening;
- cleaning the circuit elements of dust and dirt and lubrication of the friction surfac
- checking of the laying drive reducers for lubricant leakage;

Eliminate the detected faults.

4.5. PREPARING LAYING DRIVE FOR OPERATION

Make sure that:

- switches DRIVE on the turret board and on the drive control panel are at OFF;
- nothing obstructs the turret traverse, gun elevation and depression;
- the turret traverse and gun elevation (depression) are free of jamming when manual drives are used.

Besides, it is necessary to do the following:

(a) operate the elevating and traversing handwheels to bring the gun from the dangerous zone above spotlight ОУ-3ГА;

(b) switch over the reducers of the elevating and traversing mechanisms for operation from the electric motors, for which purpose press button 21 (Fig.92) of the elevating mechanism and pull down button 23 (Fig.91) of the turret traversing mechanism;

(c) set switches DRIVE on the turret board and on the laying drive control panel to ON, which should lead to lighting up of white signal lamp DRIVE on the signal panel and red signal lamps CLOSE HATCHES (two lamps in the troop compartment and one lamp in the driving compartment).

4.6. PROBABLE TROUBLES OF LAYING DRIVES

Trouble	Cause	Remedy
When switches DRIVE on the control panel and turret board are turned on the traversing drive is inoperative, whereas the elevation drive operates	The automatic circuit breaker has operated (switch) DRIVE on the turret board is off)	Turn on switch DRIVE, and if it is cut off again switch off the electric drive and use the manual drive.
When switches DRIVE are turned on both elevation and traversing drives are inoperative and the signal lamps are off	Burnt 20-A fuse on the turret distributing board	Replace the fuse and turn on switches DRIVE. If the fuse burns out again, turn off switch DRIVE and use the manual drives. Use the first opportunity to check the electric drive circuits and eliminate the trouble
When switches DRIVE are turned on the signal lamps (one or all) are off, while the electric drive operation	Faulty signal lamps	Operation of the electric drive is allowed. Replace the faulty lamps as soon as situation permits

[redacted]

is normal in both planes of laying		
When switches DRIVE are turned on the elevation motor rotates at the maximum speed with the control handles in neutral position, or is uncontrollable though the control handles are shifted	Faulty polarized relay P2, type PП-5	Replace elevation drive relay P2. After replacement of the relay it is allowed to adjust the elevation drive minimum speed with the aid of resistor R7 (elevation) located under the plug in relay box KP-6. Call the specialists for replacement of the relay and adjustment. Before the relay is replaced use the manual drive
When the control panel is turned a variation in the angle of turn does not lead to a change in the turret traverse speed, or the electric motor fails to start operating when the control panel is turned	Faulty polarized relay P1, type PП-5	Replace relay P1. After replacement of the relay it is allowed to adjust the traversing drive minimum speed with the aid of resistor P10 located under the plug in relay box KP-6. Call the specialists for replacement of the relay. If needed, use the manual drive before the relay is replaced

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5. SIGHTING, VISION AND ORIENTATION EQUIPMENT

5.1. GENERAL

Mounted in the infantry combat vehicle are sight 1ПН22М1, commander's vision device ТКН-3Б, nineteen vision devices ТНПО-170 for the troopers and vehicle crew, driver's night vision device ТВНО-2 and vision device ТНПО-350Б. for driving of water-borne vehicle. Gyro direction indicator ГПК-59 is installed in the vehicle for orientation.

5.2. SIGHT 1ПН22М1

5.2.1. Purpose

The sight is intended to conduct aimed fire from the coaxial mount and ATGM launcher.

The sight is a periscopic, combined (day and night observation with no special infrared light source). It is secured by five studs to a flange welded to the turret roof to the left of the gun. From the outside the sight head is protected with an armour cap, closed in front by the glass.

5.2.2. Design

The sight (Fig.97) consists of housing 27, head 1, the angle transmission mechanism, azimuth adjustment mechanism 19 and elevation adjustment mechanism 21, blind actuating mechanism 29, temperature correction mechanism 28, optical system, electronic and electrical equipment. The sight construction unites the day and night systems (Fig.98).

The sight housing is the base for attachment of all elements.

Arranged on the right side of the sight housing are: mechanism 30 (Fig.97) for connection of the sight head mirror with the gun, head mirror rocking mechanism 20, the setting lever installed in the body of the elevation adjustment mechanism 21 and rod 22 connecting the sight with the gun.

Protruding below the elevation adjustment mechanism is the end of the worm shaft with a slot intended for elevation adjustment.

Located on the housing front wall are eyepiece 23, headrest 24, temperature correction handle 4, blind handle 15, azimuth adjustment mechanism 19, illumination unit 5, wiper knob bracket 6, two rollers for the wiper cable and control panel 7.

Attached to the sight housing left side is the night branch objective. The objective has light filter knob 16 and two desiccators.

Secured to the housing rear is the magnifying glass, and from above, head 1.

The sight head mounts rocking mirror 2 (Fig.99), installed in mounting 4 connected with toothed sector 7, which is in its turn connected with the toothed sector of the angle transmission mechanism. The mirror is installed in the initial position by means of screws 8 during adjustment of the sight at the Manufacturing plant.

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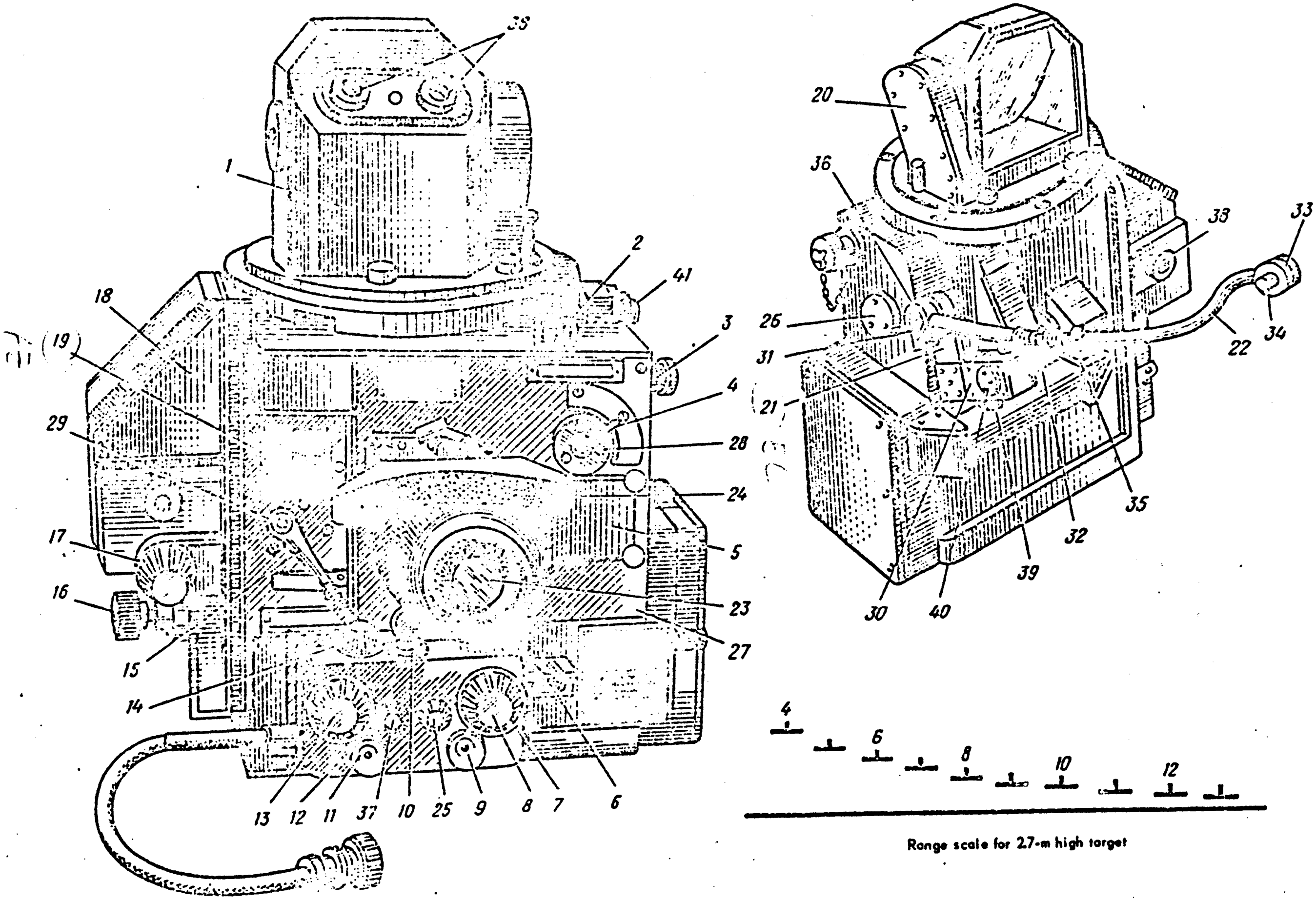
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4
6
8
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12

Range scale for 2.7-m high target

FIG.97. SIGHT 1111122M1

1 - head; 2 - roller; 3 - aviation cartridge; 4 - temperature correction handle; 5 - illumination unit; 6 - wiper knob bracket; 7 - control panel; 8 - lamp filament rheostat knob; 9 - DAY mode of operation button; 10 - power pack switch; 11 - NIGHT mode of operation button; 12 - signal lamp; 13 - illumination lamp filament rheostat knob; 14 - fuse BII-1-1-1A; 15 - blind handle; 16 - light filter knob; 17 - night objective focusing adjustment mechanism; 18 - night system objective; 19 - azimuth adjustment mechanism; 20 - head mirror rocking mechanism; 21 - elevation adjustment mechanism; 22 - rod; 23 - eyepiece; 24 - headrest; 25 - DAY mode of operation signal lamp; 26 - cover; 27 - housing; 28 - temperature correction mechanism; 29 - for connection of the sight head mirror with the gun; 31 - rod split coupling; 32 - turnbuckle; 33 - rod hinge; 34 - rod pin; 35 - locking bolt; 36 -

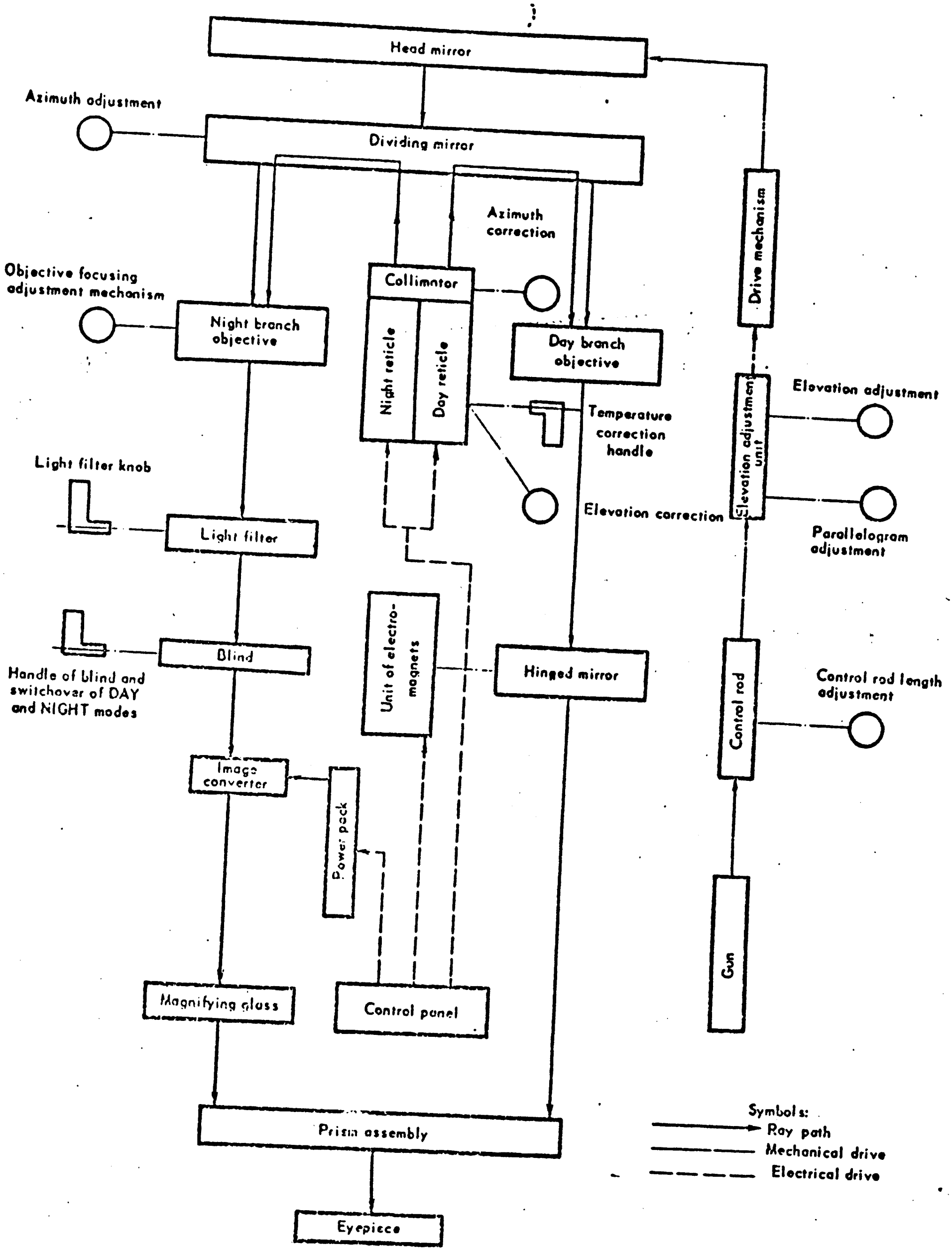
Head mirror
Azimuth adjustment
Dividing mirror
Azimuth correction
Drive mechanism
Objective focusing adjustment mechanism
Collimator
Night branch objective
Night reticle
Day reticle
Day branch objective
Temperature correction handle
Elevation adjustment
Elevation adjustment unit
Light filter knob
Elevation correction
Parallelogram adjustment
Light filter
Blind
Unit of electro-magnets
Hinged mirror
Control rod
Control rod length adjustment
Handle of blind and switchover of DAY and NIGHT modes
Image converter
Power pack
Gun
Magnifying glass
Control panel
Prism assembly
Symbols:
Ray path
Mechanical drive
Electrical drive
Eyepiece

FIG.98. SCHEMATIC BLOCK DIAGRAM OF SIGHT

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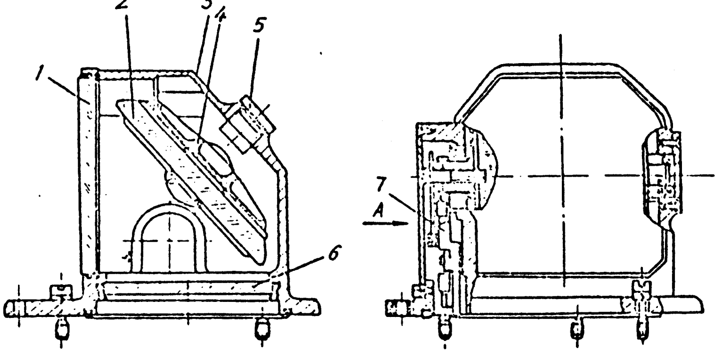

View A

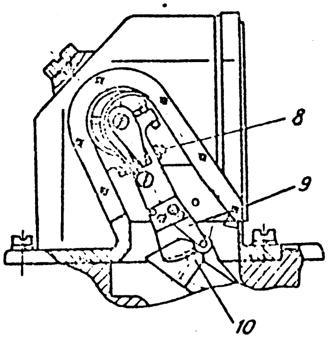

FIG.99. SIGHT HEAD

1, 6 - protective glasses; 2 - mirror; 3 - head housing; 4 - mirror mounting; 5 - desiccator; 7 - toothed sector; 8 - screw; 9 - lever with roller; 10 - cam

The front and lower windows of the head are closed with protective glasses 1 and 6. Placed in the head upper portion are two desiccators 5 intended to prevent sweating of the sight glasses inner surfaces.

The desiccator consists of the body, drying agent and packing. The drying agent is silica gel, which has the property of absorbing moisture penetrating inside the sight.

Silica gel colour tells about its quality: the blue colour means that the drying agent is serviceable, whereas pink colour means that it is unserviceable.

Correct engagement of the toothed sectors of the sight head and housing is ensured by lever 9 with roller and cam 10.

The angle transmission mechanism kinematically couples the gun with the sight head mirr

The mechanism parts are detachable rod 22 (Fig.97) with split coupling 31, setting leve (elevation adjustment mechanism 21), setting lever axle 1 (Fig.100), toothed sector 2 mounte on axle 1, twin toothed sector 3 with a cam, toothed sector 5 mounted on one axle with head mirror 6.

Rod 11 consisting of two sections has hinge 33 (Fig.97) on one end with short pin 34, which enters a hole on the gun cradle, and the rod other end terminates in a split coupling clamped on an eccentric axle by means of bolt 36.

The rod length is adjusted by means of turnbuckle 32.

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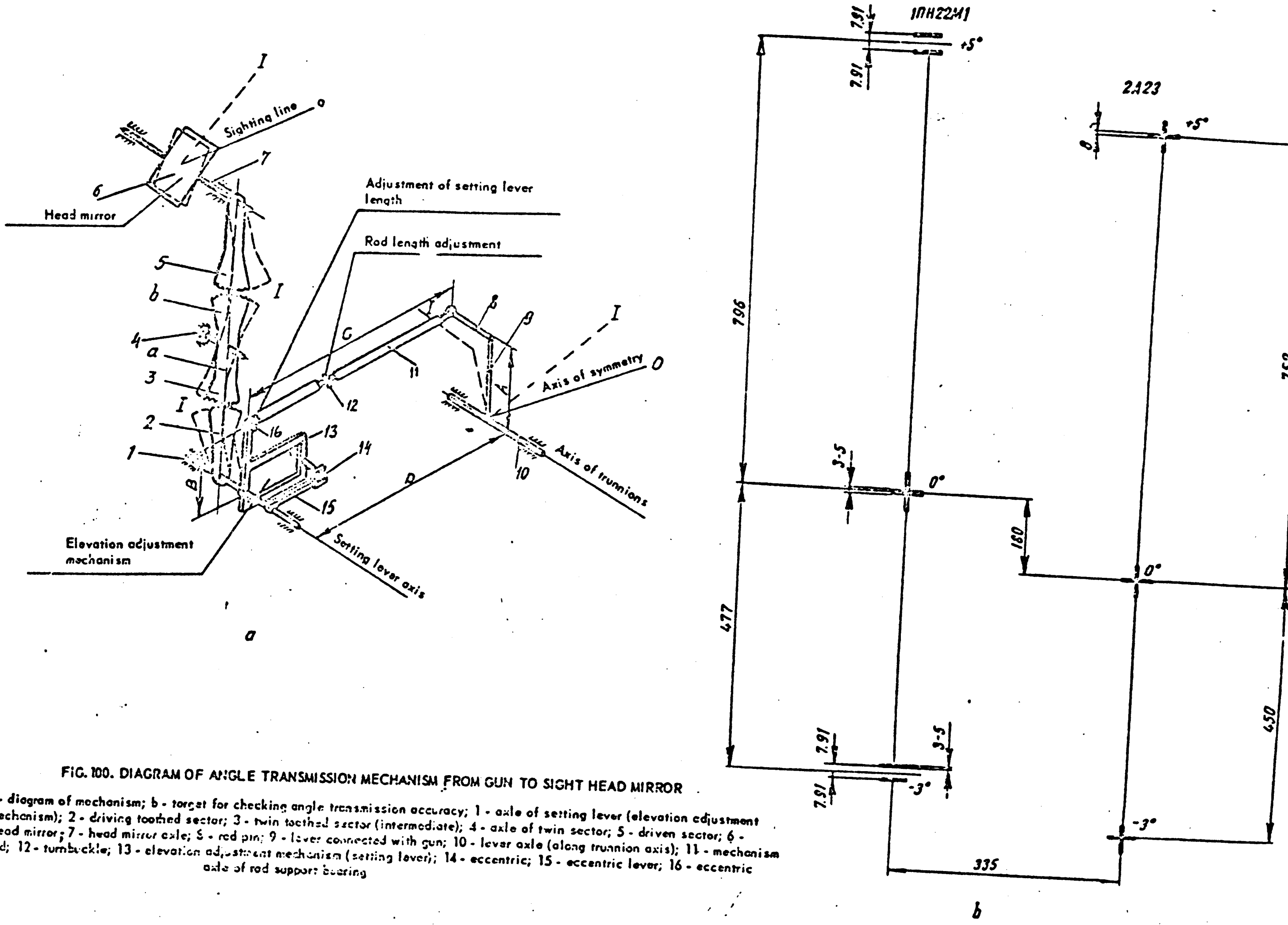
I
Sighting line
o
7
6
Head mirror
5
b
4
a
3
I
2
1
B
I
Adjustment of setting lever length
Rod length adjustment
G
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16
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14
15
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I
A
Axis of symmetry
O
10
Axis of trunnions
D
Setting lever axis
Elevation adjustment mechanism
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7.91
+5°
796
3-5
0°
477
160
7.91
7.91
3-5
-3°
335
b
2A23
8
+5°
0°
450
-3°

[redacted]

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FIG. 100. DIAGRAM OF ANGLE TRANSMISSION MECHANISM FROM GUN TO SIGHT HEAD MIRROR

a - diagram of mechanism; b - target for checking angle transmission accuracy; 1 - axle of setting lever (elevation adjustment mechanism); 2 - driving toothed sector; 3 - twin toothed sector (intermediate); 4 - axle of twin sector; 5 - driven sector; 6 - head mirror; 7 - head mirror axle; 8 - rod pin; 9 - lever connected with gun; 10 - lever axle (along trunnion axis); 11 - mechanism rod; 12 - turnbuckle; 13 - elevation adjustment mechanism (setting lever); 14 - eccentric; 15 - eccentric lever; 16 - eccentric axle of rod support bearing the head.

Transmission ratio from sector 2 to sector 3 is equal to 1:1, whereas from sector 3 to sector 5, 2:1.

As the gun is elevated (lowered) through a certain angle, sectors 2 and 3 are turned through the same angle, and sector 5 together with the head mirror are turned through half this angle. This arrangement ensures deflection of the line of sight through the same angle as the gun, since when the mirror is turned through any angle, the line of sight is deflected through a twice greater angle due to reflection from the mirror.

Alignment of the barrel bore axis deflection with deflection of the sight optical axis is ensured by equality of the arms of the parallelogram formed by arm A (distance from the gun trunnion axis to rod 11 attachment pin axis), arm B (distance from setting lever axle 1 to the axle of rod 11 attachment to the lever) and arm D (distance between gun trunnion axis and the setting lever axis).

The length of arm B may be adjusted by turning eccentric axle 16 which carries the rod bearing and by varying the length of rod 11 by rotation of turnbuckle 12.

The elevation adjustment mechanism is intended for adjustment of the zero line of sight in range (height) simultaneously for the day and night branches of the sight.

The adjustment is accomplished by turning the head mirror. The adjustment mechanism consists of lever 1 (Fig.101), toothed sector 2, axle 3, worm wheel 4 and worm 5. For adjustment, insert a screwdriver in worm 5 shaft slot and turn the shaft. From the worm motion is transmitted to worm wheel 4 and then to eccentric 6, which turns fork 7 fitted on axle 3 and sector 2, which turns the mirror through intermediate sectors. The motion from the gun to the head mirror is transmitted through rod 22 (Fig.97), setting lever 13 (Fig.100), worm wheel 4 (Fig.101), eccentric 6, fork 7, axle 3 and sector 2.

The azimuth adjustment mechanism (Fig.102) is intended for simultaneous adjustment of the day and night branches of the sight in azimuth. The adjustment is performed by turning dividing mirror 4 (Fig.105).

The mechanism consists of worm 2 (Fig.102), made en bloc with the axle of worm wheel 4, the worm wheel axle with eccentric 6 entering a slot of mounting 7 of mirror 5.

The mirror mounting is installed on two half-axles.

The adjustment is accomplished using a screwdriver inserted in a slot on the end face of axle 1 of worm 2. As the worm is turned, the worm wheel together with the axle and the eccentric are also turned. The eccentric sets the mirror to the required angle. When the dividing mirror turns, the sight night branch displays a shift of the image of objects in a horizontal direction with respect to the fixed image of the sight reticle. Simultaneously in the day branch of sight, the image of the sight reticle displaces with respect to the fixed image of the observed objects in the same direction and by the same value as in case of the night branch.

Retainer 3 is used to fix the adjustment from disturbance.

The temperature correction mechanism is designed to introduce temperature correction to the sight day branch during firing under conditions of high or low ambient temperature, which is outside the limits of -10 to +10°C.

The correction must be introduced as the ballistic properties depend on the ambient temperature.

The mechanism has a scale for three ranges of averaged temperatures: correction "-20" - for temperatures below -10°C, "+20" - for temperatures above +10°C and zero correction "0" - for temperatures from +10°C up to -10°C.

The mechanism consists of handle 6 (Fig.103) secured on axle 7 with screw 8, screw 3 screwed on whose thread is cover 2, carriage of day reticle assembly 4, scale 5 and spring retainer 1 engaged with the teeth of the ratchet made integral with screw 3.

As handle 6 is turned, axle 7, whose end enters a slot of screw 3, turns the screw and screws it in the thread of collimator cover 2, displacing the carriage with the day reticle.

[redacted]

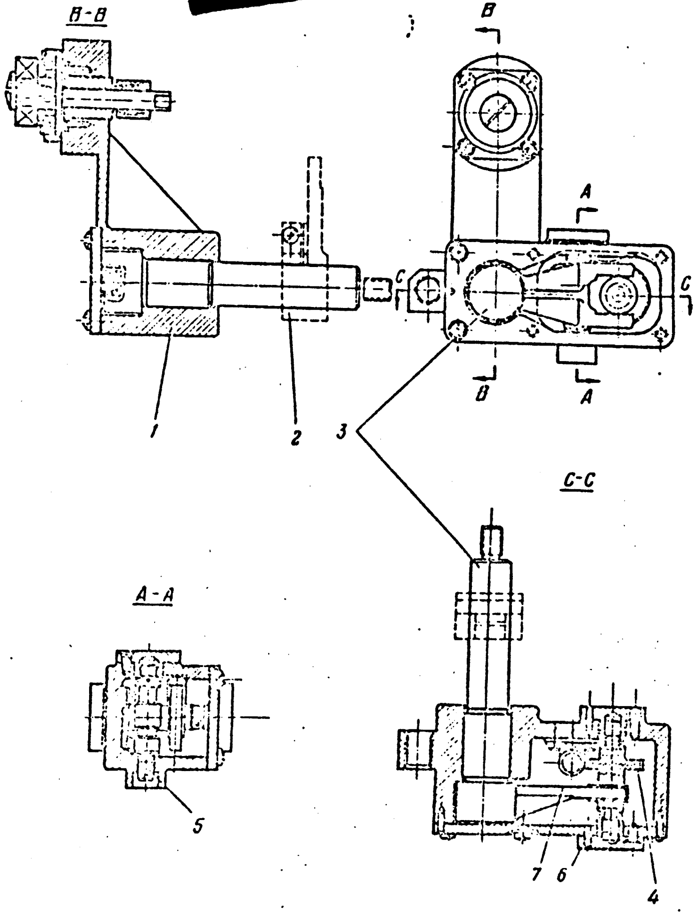

FIG. 101. ELEVATION ADJUSTMENT MECHANISM

1 - lever; 2 - toothed sector; 3 - axle; 4 - worm wheel; 5 - worm; 6 - eccentric; 7 - fork

When screw 3 is turned out, the reticle goes in the opposite direction under the action of the spring. The value of the reticle angular travel, corresponding to the handle shifting from scale mark "-20" up to "+20" is equal to eight minutes.

The blind actuating mechanism serves to prevent exposure of the image converter to light and to switch over the sight modes of operation (DAY-NIGHT).

The mechanism consists of body 1 (Fig.104), two electromagnets 2, blind 9, hinged mirror 3, two microswitches 10 and manual switchover handle 15 fitted on axle 8.

For operation at night, it is necessary to depress left button NIGHT (Fig.97), thus supplying current to the winding of left electromagnet 2 (Fig.104). Due to the induced electromagnetic field armature 13 moves in and turns axle 4 through angle piece 12 and carrier 11. Axle 4 carries freely fitted blind 9 on one end and hinged mirror 3 on the other end. Blind 9 is connected with axle 4 by rod 7. As axle 4 is turned, mirror 3 swings out and the blind, loaded with spring 16, opens the photocathode of the image converter.

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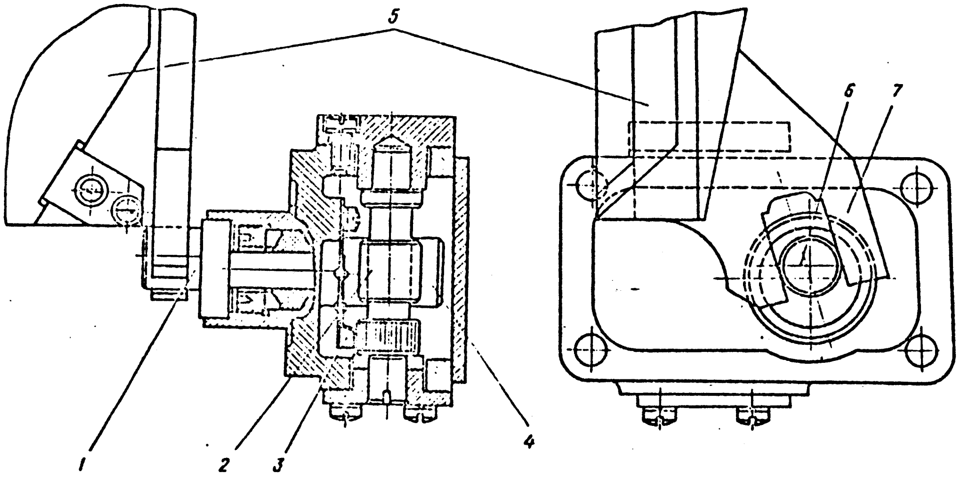

FIG. 102. AZIMUTH ADJUSTMENT MECHANISM

1 - axle; 2 - worm; 3 - retainer; 4 - worm wheel; 5 - mirror; 6 - eccentric; 7 - mirror mounting

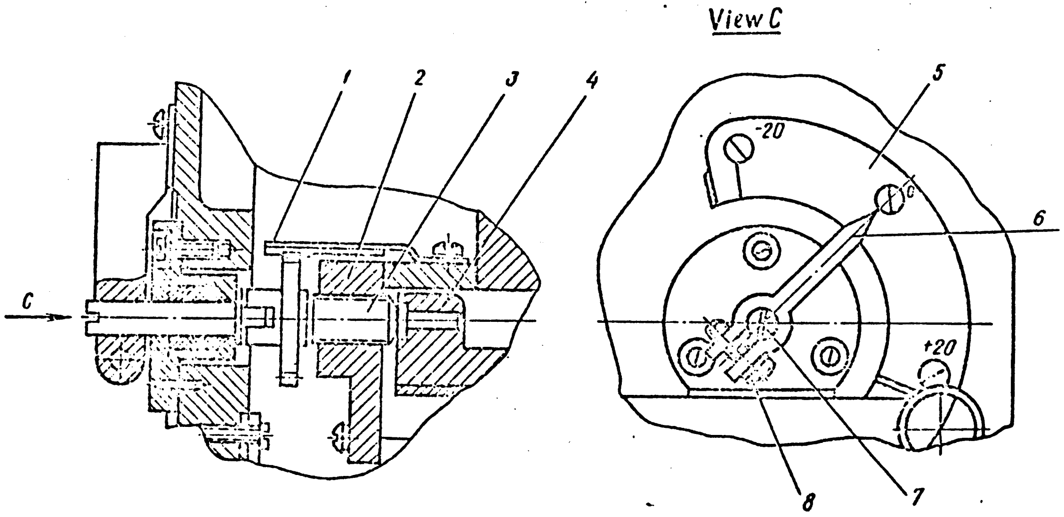
View C
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FIG. 103. TEMPERATURE CORRECTION MECHANISM

1 - retainer; 2 - cover; 3 - screw; 4 - day reticle assembly; 5 - scale; 6 - handle; 7 - axle; 8 - screw

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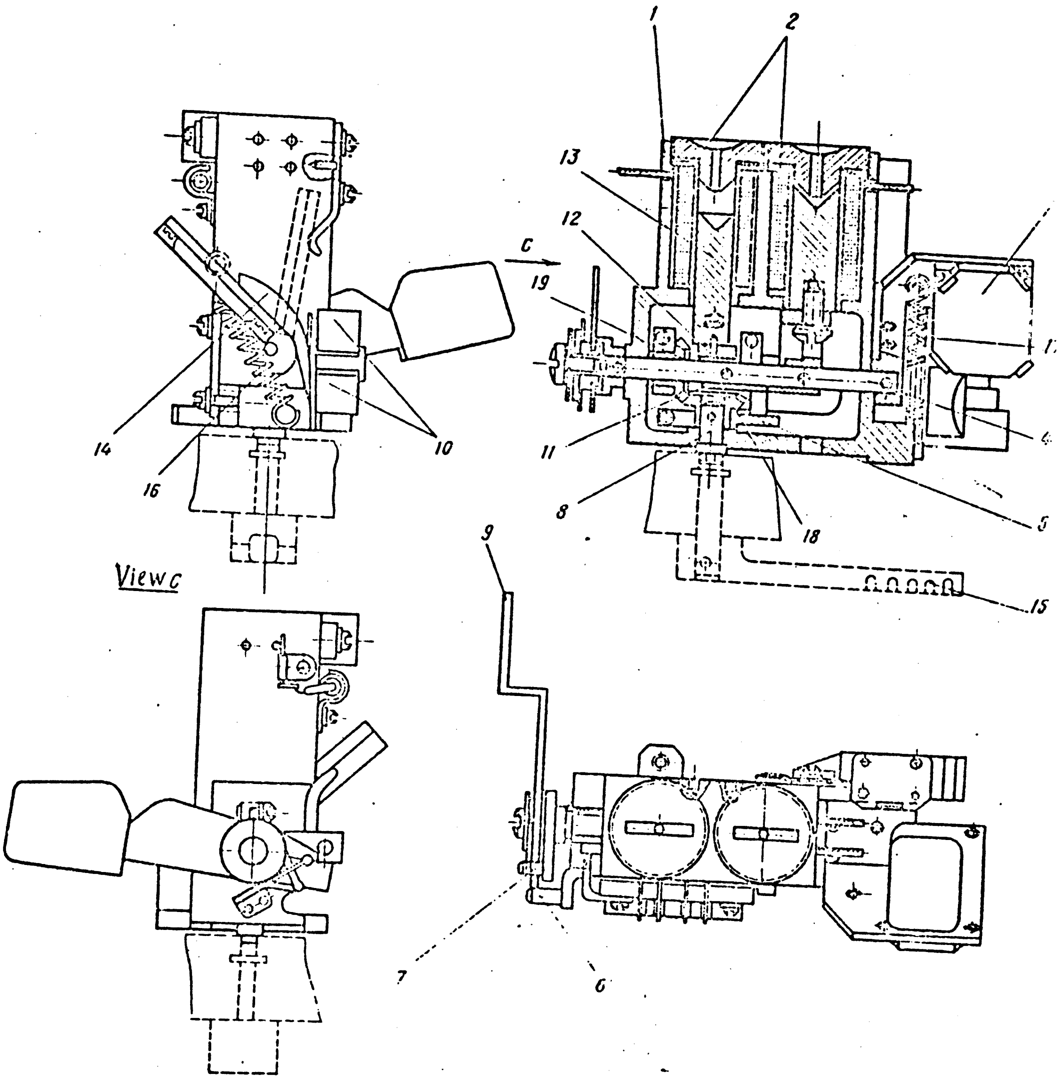
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FIG. 104. BLIND ACTUATING MECHANISM

1 - body; 2 - electromagnet; 3 - hinged mirror, 4 - axle; 5 - carrier; 6 - carrier; 7 - rod; 8 - axle; 9 - blind; 10 - microswitch; 11 - carrier; 12 - angle piece; 13 - armature; 14 - cam; 15 - handle; 16 - blind spring; 17 - mirror spring; 18, 19 - bevel gears

[redacted]

fed to right-hand electromagnet 2 (Fig. 4 in the opposite direction. Hinged mirror 3 turns together with axle 4 and is set at 45° angle with respect to the light rays passing through the day branch objective. Simultaneously rod 7 coupled with the axle turns the blind, which closes photocathode of the image converter.

Alongside with the electromagnetic actuating mechanism the blind and the mirror may be actuated manually. The manual actuating mechanism gives the possibility of partial or full covering of the image converter photocathode in the NIGHT mode, as well as of switching-over of the sight to DAY mode when the sight power supply is cut off.

The manual actuating mechanism consists of a pair of bevel gears 18 and 19, axle 8 and handle 15.

When handle 15 is turned to the right, gear 18 turns gear 19, which is freely fitted on axle 4 and is connected with carrier 6. Carrier 6 turns the blind to NIGHT mode. To switch over the sight to DAY mode, press off the limiting spring and turn handle 15 to the left. In this case carrier 5, connected with gear 18, turns axle 4 and mirror 3, setting it at 45° angle relative to the light rays.

Secured to the blind actuating mechanism body from mirror 3 side are the brackets with two microswitches 10, which are switched over by cam 14 when the mirror is turned.

5.2.3. Sight Optical System

The sight optical system (Fig.105) is a combination of the day and night branches.

The elements common for both branches are protective glass 1, head mirror 2, two protective glasses 3, dividing mirror 4, prism relay optical system 25 and 26 and eyepiece lenses 27, 28, 29, 30, 31, 32, 33 and 34.

In addition, the day branch includes objective lenses 44 and 45, and mirror 24.

The night branch includes in addition objective lenses 5, 6, 7, 9 and 10, mirror 8, prism 11, light filter unit 12, 13, 14, 15, 16, 17, image convertor 18, prism relay optical systems 21 and 46, lens relay optical system 19, 20, 22 and 23.

The day optical system operates as follows. The light rays from the observed objects pass through protective glass 1 to head mirror 2, wherefrom they are reflected and, after passing through protective glasses 3, fall on dividing mirror 4. Dividing mirror 4 middle portion is not coated with the reflecting layer, therefore a portion of rays passes through it to the day branch objective 44 and 45 and inverted image of the objects is formed in its focal plane. Then the rays fall on hinged mirror 24, inclined at 45° (shown by dotted line in Fig.105), which reflects them to prism relay optical system 25 and 26, and the latter reinverts the image formed in the objective. This image is viewed through the day branch eyepiece.

The night branch optical system operates as follows.

During operation at night (mirror 24 is moved off) the rays reflected from dividing mirror 4 get into the night branch objective consisting of two groups of lenses 5, 6 and 7, 9 and 10 with mirror 8 installed in-between.

From the night branch objective the rays pass through prism 11, where they are deflected by 90° and, after passing the light filter, fall on the photocathode of the image converter. The photocathode is positioned in the focal plane of the objective. The image converter intensifies the brightness of the image and projects it on the screen. The rays from the image on the screen pass through prism relay optical system 46, lens relay optical system 19 and 20, prism relay optical system 21, lens relay optical system 22 and 23, prism relay optical system 25 and 26 to eyepiece 27-34, and thus, the image on the image converter screen is viewed through the eyepiece.

The image converter is arranged in a plastic housing, accommodating the power pack as well.

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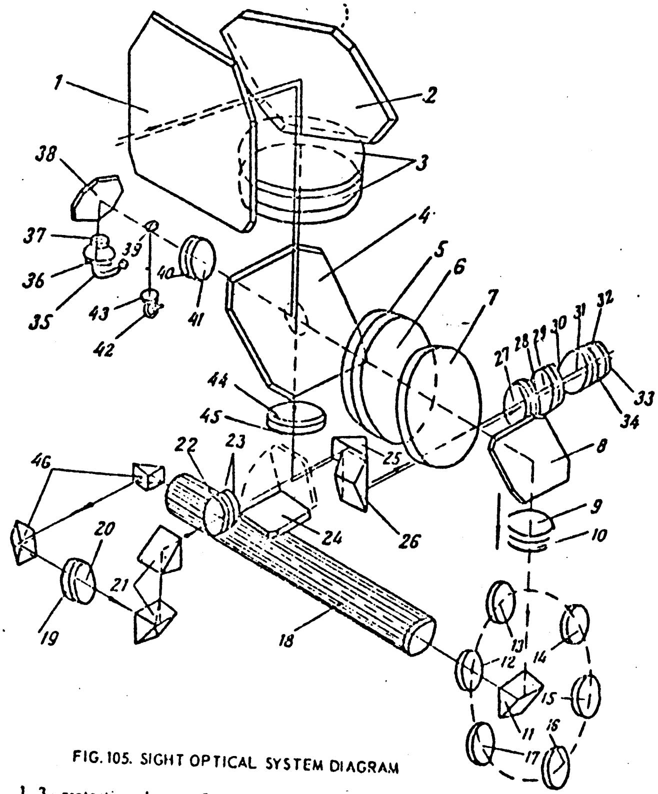
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FIG. 105. SIGHT OPTICAL SYSTEM DIAGRAM

1, 3 - protective glasses; 2 - head mirror; 4 - dividing mirror; 5, 6, 7, 9, 10 - night branch objective lenses; 8, 38 - mirrors; 11 - prism; 12, 13, 14, 15, 16, 17 - light filter unit; 18 - image converter, 19, 20, 22, 23 - lens relay optical system; 21, 46 - prism relay optical systems; 24 - hinged mirror; 25, 26 - prism relay optical system; 27, 28, 29, 30, 31, 32, 33, 34 - eyepiece lenses; 35 - day reticle illumination lamp; 36 - lens; 37 - day reticle; 39 - mirror; 40, 41 - objective lenses; 42 - night reticle illumination lamp; 43 - night reticle; 44, 45 - day branch objective lenses

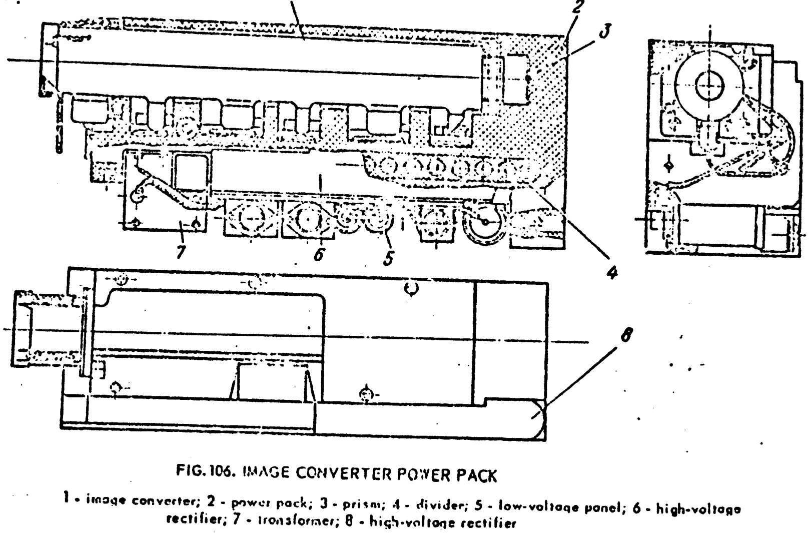

FIG. 106. IMAGE CONVERTER POWER PACK

1 - image converter; 2 - power pack; 3 - prism; 4 - divider; 5 - low-voltage panel; 6 - high-voltage rectifier; 7 - transformer; 8 - high-voltage rectifier

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pack 2, low-voltage panel 5, transformer 7 and high-voltage

The image converter is a glass flask, from where air is evacuated. Applied to the inner side of the flask front wall is a layer sensitive to weak visible light (photocathode). Welded inside the flask are three tapered anode sleeves, having diaphragms installed in their narrow necks, secured from the opposite side in the first sleeve is the optical contact of the first and second image converter chambers, in the second sleeve, the optical contact of the second and third chambers, and in the third sleeve, the screen.

The optical contact is a transparent mica plate dividing the flask into separate chambers, each of them operating as conventional single-chamber image converter.

The surfaces of both mica plates on the side facing the photocathode are coated with a layer of luminophore – the substance capable of producing visible light when "bombarded" by the electrons (screens of first and second chambers). Applied to the opposite surfaces of the plates is the layer sensitive to visible light, i.e. photocathodes of the second and third chambers. Thus, the image converter consists of three series-connected image converters with three photocathodes and three screens.

The third chamber screen is made on a glass disc soldered at the bottom of the third chamber anode sleeve. The disc is coated with luminophore which becomes luminous under action of the electrons.

The front cylindrical part of each chamber is coated with metal amalgam, which plays the role of focusing electrodes.

Four legs are welded into the image converter flask and a metal ring is fitted on the first chamber photocathode.

Connected to the legs and ring are the conductors from the image converter electrodes, which are fed with the corresponding potentials from the power pack voltage divider (up to 15.000 V).

The principle of the image converter operation consists in the following: when weak visible light rays (natural lighting at night) get on the first chamber photocathode, the latter emits electrons under the influence of supplied high voltage and the electrons "bombard" luminophore on the screen. Under action of the electrons the screen emits visible light rays of greater brightness which fall on the next photocathode and generate a new flow of electrons in the second chamber.

In the third chamber the effect is magnified still further, thereby increasing brightness of the image.

The power pack supplies the image converter with H.V. current. It converts direct current of the vehicle mains into H.V. direct current of two polarities (±15.000 V).

The power pack consists of voltage stabilizer (Fig.114), self-excited oscillator, rectifier, voltage divider and radio interference filter.

The voltage stabilizer incorporates two stabilitrons Д3, Д4 (Д814В), transistor T1 (П217Г), two capacitors C3, C4 (Эгц – а $\frac{30}{50}$ Ом), resistor R1 (ОМЛТ – 0.5470). It is intended to stabilize the voltage applied to the self-excited oscillator, since voltage in the vehicle mains may vary from 22 up to 30 V.

Connected at the stabilizer input are two diodes Д1, Д2, (Д226А), preventing accidental polarity change in the circuit.

The self-excited oscillator consists of transistor T2 (П217Г), high-frequency transform Tp1, bias circuit resistor R4 (ОМЛТ-0.5-4.7 kОм±10%), resistor R3 in the circuit of the base diode Д5 (Д226А) and capacitor C5 (МБГО-1-160б-10 μF). The self-excited oscillator convert direct current into alternating current of about 10 kV, which is fed to the rectifier.

The rectifier employs 18 selenium stacks Д6-Д23 (3ГЕ220АФ) and six capacitors C6-C11 (К74-7-390), forming the voltage multiplication circuit, where the voltage is increased two times (up to 15.000 V).

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The voltage divider employs nine resistors R11-R19 (КЭВ-0.5-5.1 ГОм). To create difference of the potentials between the basic and focusing electrodes of the image converter the divider includes resistors R5- R10 (КИМ-Е10-100 МОм).

The radio interference filter consists of two duct capacitors C1 (КБП-С-125-20-1.0) and C2 (КБП-Р-125-10-01) connected at the input of the power pack circuit. The high-frequency components of AC voltage of 150 kHz or more, appearing in the power pack, are passed by these capacitors to the frame.

The power pack housing is installed into the common housing of the image converter unit and is attached to it with four screws.

The projection collimator serves to obtain the image of the day and night reticles in the sight field of view. It consists of an illuminating unit, night reticle 12 (Fig.107) and objective 5.

The illuminating unit includes night reticle lamp 19 and day reticle lamp 13 secured to bracket 15. Secured on the bracket are also two spare lamps.

The day reticle (Fig.108a) serves to introduce angles of elevation during day firing. The reticle is made on nontransparent glass plate carrying transparent index lines, which are numbered 4, 6, 8, 10 and 12 corresponding to the target ranges in hundreds of meters. Two lower rows of inverted V-marks, marked by number 13, serve for firing at 1300-m range, using the upper row for firing at 0°C temperature, and the lower one - at below-zero temperatures. While firing at 1300-m range at above-zero temperatures, the aiming is done by the lower edge of the index lines marked with number 12.

The temperature correction common for all ranges (1300-m range included) is introduced by the special temperature correction mechanism.

The deflection correction lines are marked at an interval of 0-05, numbers 10 and 20 indicate the correction value in mils.

Located to the right of the reticle is the range finding scale designed for the targets 2.7-m high (tank height, approx.). To find the distance it is necessary to aim the scale on the target so that the target is located between the horizontal line and the upper index line, then the number above the corresponding index line indicates the distance to the target in hundreds of meters.

The crosshairs in the lower portion of the reticle is used for guiding of ATGMs.

The day (and night) reticles are designed for firing the gun and machine gun.

The reticle is secured in the carriage, consisting of panel 2 (Fig.107) and slider 3. The carriage may be moved by means of screws 1 and 11 in two mutually perpendicular planes.

Screw 1 protrudes outside the sight and is connected with the temperature correction mechanism shaft. Screw 11 is closed with a cover bearing inscription CORRECTION DAY-HORIZON (ПОПРАВКА ДЕНЬ-ГОРИЗОНТ).

The night reticle (Fig.108b) is similar in design to the day reticle, i.e. it has transparent index lines on nontransparent glass. The apex of the inverted V-mark and the top edges of the index lines, arranged along the vertical axis, serve as the sighting points for 400, 600 and 800-m ranges at above-zero temperatures (higher than +10°C). The lower ends of the index lines and inverted V-mark serve as the sighting points for firing at below zero temperatures (below -10°C). At a temperature range from +10 up to -10°C the aiming is performed using middle points of the index lines and inverted V-mark.

The deflection correction lines are marked at the interval of 0-10. The reticle is fixed.

When the sight operates in the DAY mode, lamp 35 (Fig.105) is switched on. The light from the lamp passes through lens 36, transparent index lines of reticle 37, is reflected from mirror 38 to collimator objective (lenses 40, 41). The reticle image formed in the collimator objective focal plane, after being reflected from mirror 4 is passed in the day branch objective where it is superimposed on the terrain image.

[redacted]

[redacted]

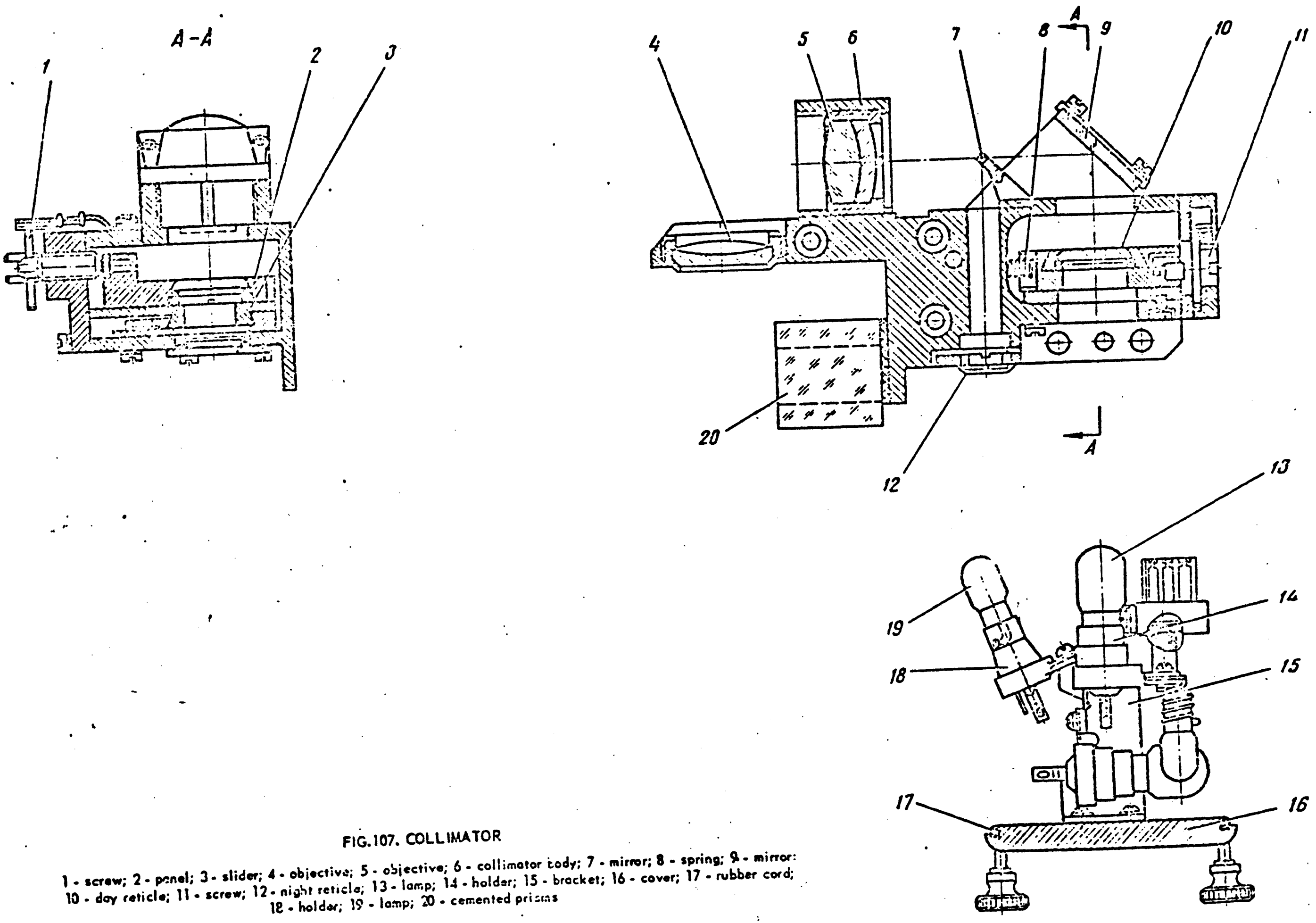

A-A
1
2
3
4
5
6
7
8
A
9
10
11
12
20
A
13
14
15
16
17
18
19

FIG.107. COLLIMATOR

1 - screw; 2 - panel; 3 - slider; 4 - objective; 5 - objective; 6 - collimator body; 7 - mirror; 8 - spring; 9 - mirror; 10 - day reticle; 11 - screw; 12 - night reticle; 13 - lamp; 14 - holder; 15 - bracket; 16 - cover; 17 - rubber cord; 18 - holder; 19 - lamp; 20 - cemented prisms

[redacted]

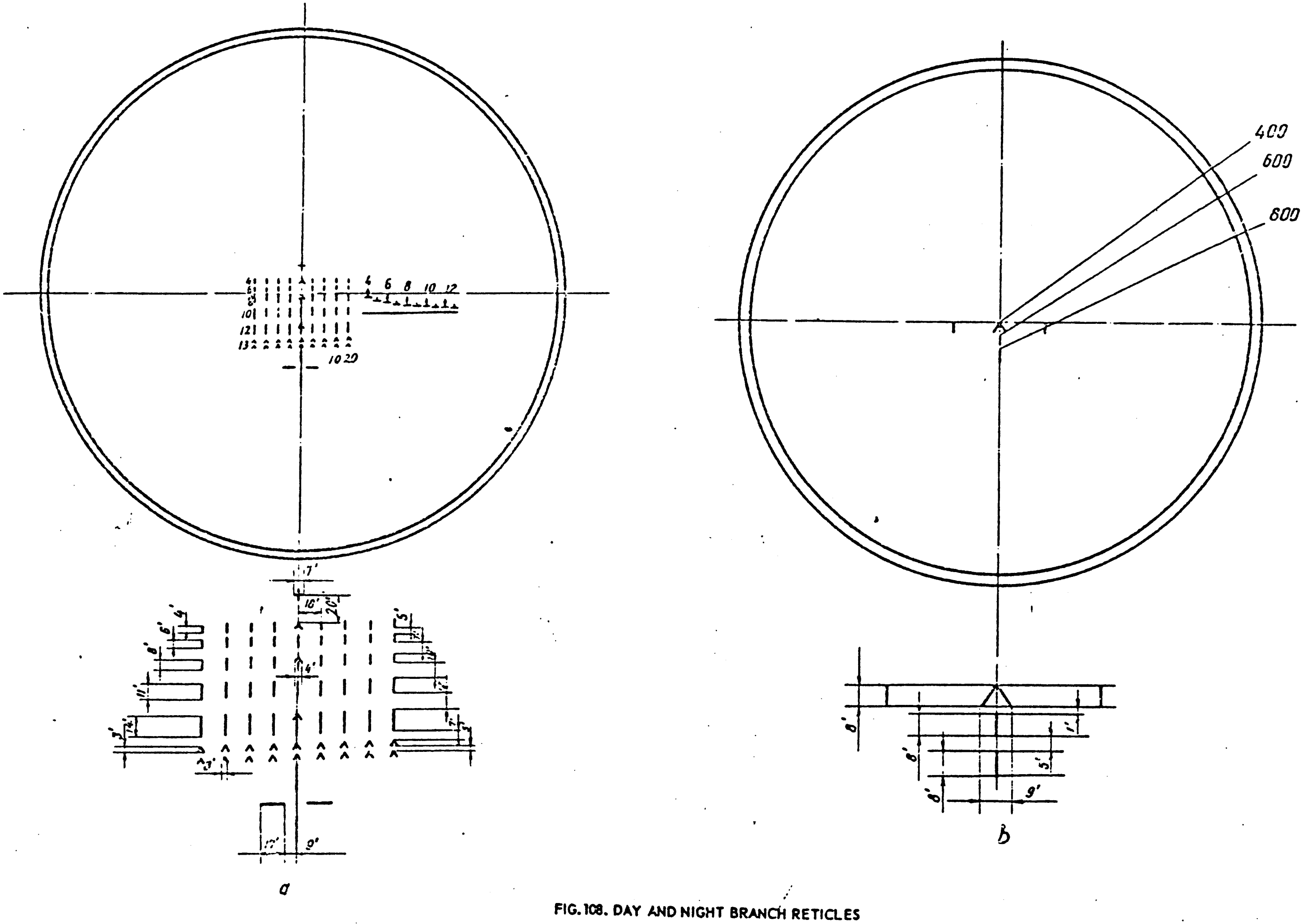
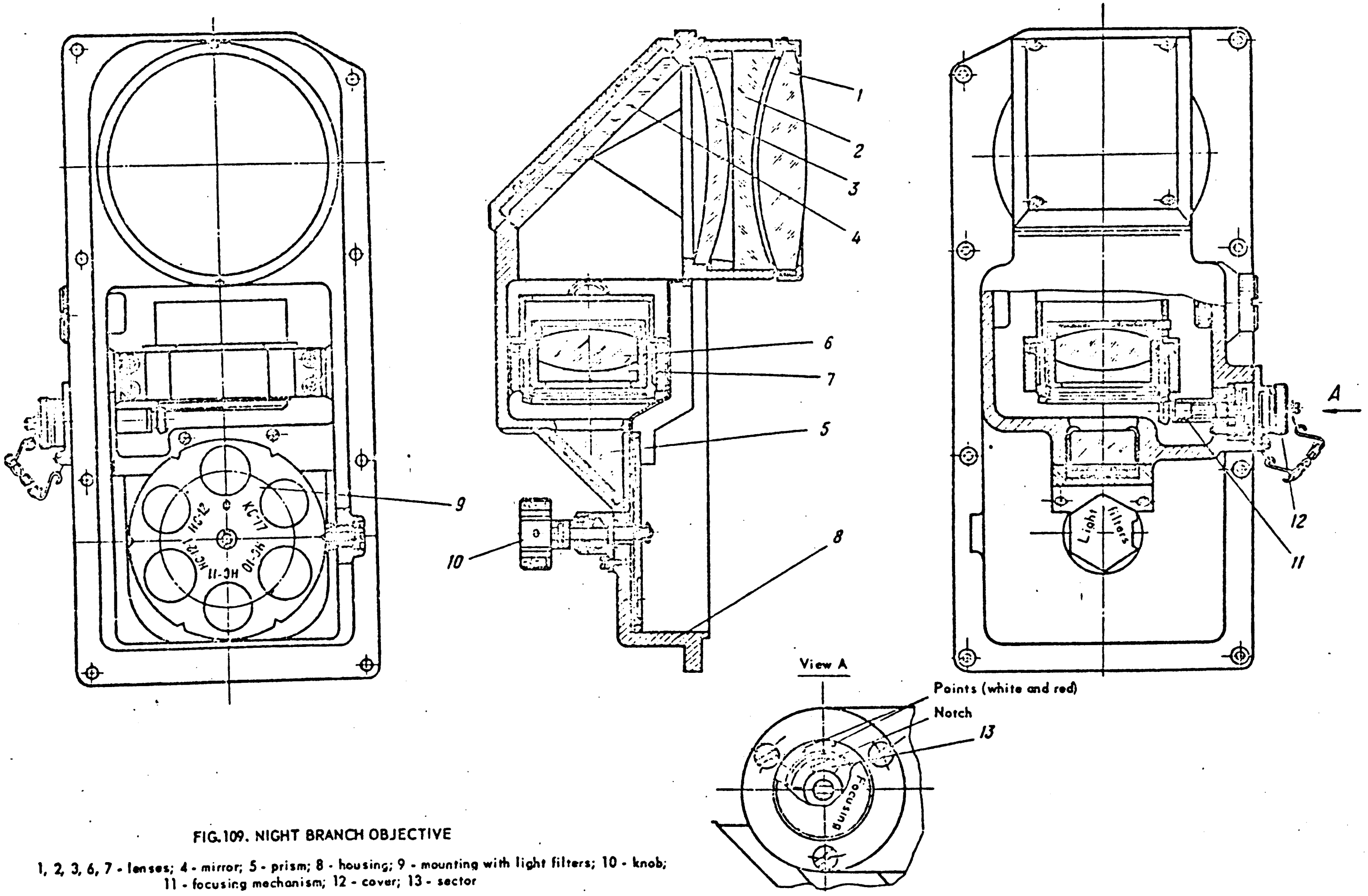

4 6 8 10 12
4
6
8
10
12
13
10 20
7'
16'
20'
4'
5'
6'
8'
11'
14'
3'
9'
12'
a
400
600
800
8'
1'
5'
9'
b

FIG. 108. DAY AND NIGHT BRANCH RETICLES

a - day branch reticle; b - night branch reticle

[redacted]

[redacted]



1
2
3
4
6
7
5
9
10
8
A
12
11
View A
Points (white and red)
Notch
13
Focusing
Light filters
KC-17
HC-10
HC-11
HC-12
HC-12

FIG. 109. NIGHT BRANCH OBJECTIVE

1, 2, 3, 6, 7 - lenses; 4 - mirror; 5 - prism; 8 - housing; 9 - mounting with light filters; 10 - knob; 11 - focusing mechanism; 12 - cover; 13 - sector

[redacted]

[redacted]

sight operates in the NIGHT mode, lamp 42 is switched on. The lamp light passes through transparent lines of reticle 43, is reflected from mirror 39 and falls in collimator objective. The reticle image, formed in the focal plane of the collimator obje passes through the central part of mirror 4 into the night objective, where it is superim ed on the terrain image.

The night branch objective is designed to project the object image on the image conv photocathode.

It consists of fixed lenses 1, 2 and 3 (Fig.109), mirror 4, prism 5 and movable lens 6 and 7.

Placed in the objective lower part are the light filter in mounting 9, knob 10 and or the side, the objective focusing mechanism 11. This mechanism is closed with a cover havi inscription FOCUSING (ФОКУСИРОВКА). Placed under the cover is sector 13 with a splined sh which is connected through a pair of bevel gears with the movable mounting of the objecti lenses.

The sector has a mark, and the flange has white and red points. The points serve for adjustment of the objective focusing during seasonal changes of temperature. Light filters mounting 9 serves to introduce one of the light filters in the night branch.

The mounting knob 10 is brought out. The inscriptions on the knob side facing the ope indicate what filter is set in front of the image converter photocathode. Installed in th mounting are six filters, intended:

O and KC-17 - for operation under conditions of natural night lighting,

HC-10 - for operation in twilight,

HC-11 - for daytime operation in cloudy weather,

HC-12-1 and HC-12 - for daytime operation in sunny weather.

The filters are chosen by visual check.

The eyepiece (Fig.110) consists of fixed eyepiece holder 1 with lenses 2 and 3 and movable mounting 11 with lenses 4, 5, 6, 7, 8 and 9. The eyepiece is equipped with the electric heating system, consisting of spiral 13, insulation block 14 and wire 15.

Rubber eyeshield 12 is secured to the eyepiece.

The movable mounting is rotated in the thread, thus the eyepiece is adjusted to the operator's eye. The eyepiece is furnished with a braking device made of a knurled ring and spring 16 preventing spontaneous rotation of the eyepiece.

The telescopic magnifying glass (Fig.111) is designed to transmit the image projected on the image converter screen in the sight eyepiece. It consists of aluminium branch pipes 2 and 3, three prisms 1, 4 and 7, lens relay optical system 5 and 6.

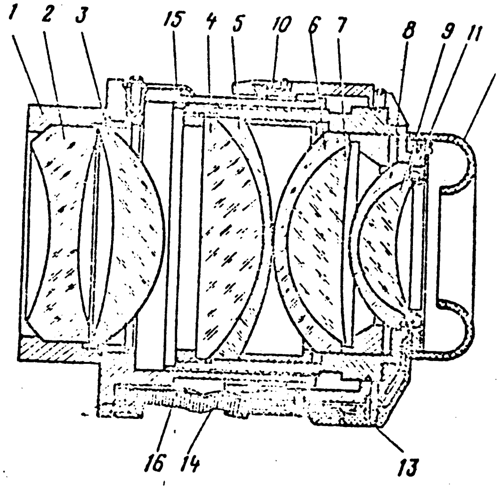


FIG.110. EYEPIECE

1 - eyepiece holder; 2, 3, 4, 5, 6, 7, 8, 9 - lenses; 10 - ring; 11 - mountin 12 - eyeshield; 13 - spiral; 14 - block; 15 - wire; 16 - spring

5.2.4. Control Panel (Fig.112)

The control panel (Fig.112) consists of housing 7, accommodating all the control panel elements.

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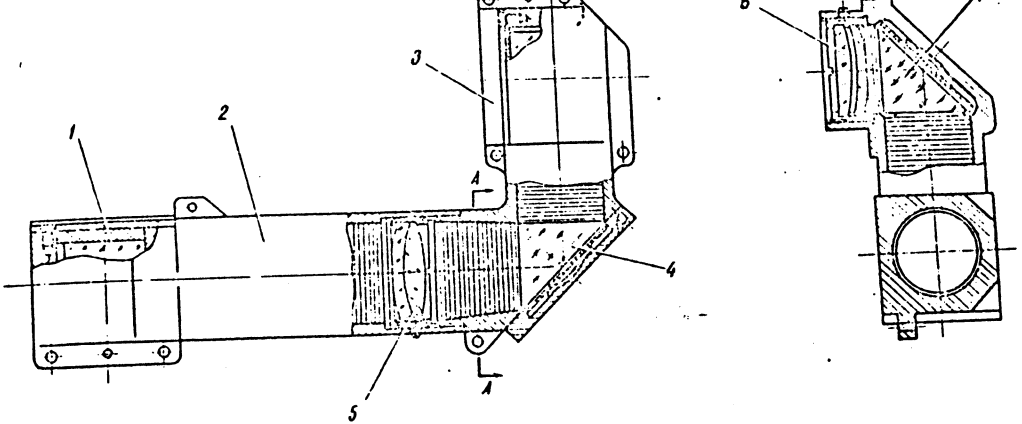

FIG.111. TELESCOPIC MAGNIFYING GLASS

1 - prism; 2 - branch pipe; 3 - branch pipe; 4 - prism; 5, 6 - lens relay optical system; 7 - prism

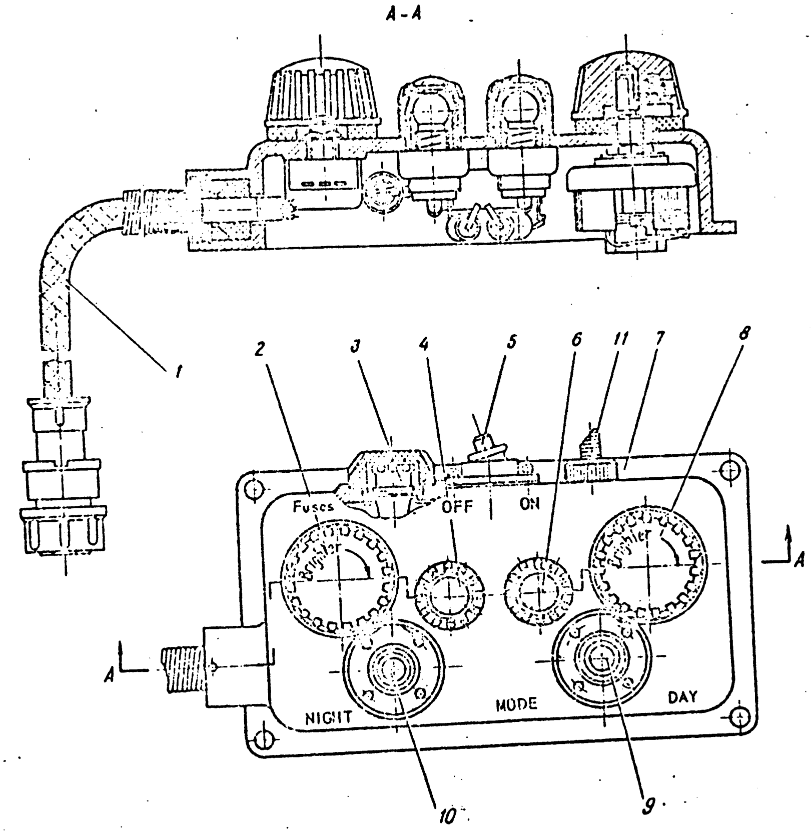
A - A
1
2
3
4
5
6
11
7
8
Fuses
OFF
ON
Brighter
Brighter
A
A
NIGHT
MODE
DAY
10
9

FIG.112. CONTROL PANEL

1 - hose with electric wires; 2 - potentiometer knob; 3 - fuse; 4 - signal lamp; 5 - tumbler switch; 6 - signal lamp; 7 - housing; 8 - potentiometer knob; 9 - DAY mode of operation button; 10 - NIGHT mode of operation button; 11 - stopper

[redacted]

[redacted]

Secured on the panel left wall is hose 1 with electric wires. Arranged on the front wall are potentiometer knobs 2 and 8 for adjustment of scale illumination brightness, but tons 9 and 10 for switching over the sight from the DAY to NIGHT mode of operation and vi versa and signal lamp 4 with red light filter (indicating that night branch is on) and la 6 with green light filter (indicating that day branch is on).

Arranged on the light filter upper wall is fuse 3, tumbler switch 5 and the lead-in the eyepiece heater.

The diaphragm (Fig.113) provides for convenient adjustment of the sight in daytime. consists of base 1, secured to which on an axle is movable sector 2 with three holes of d ferent diameters. The base has a window for installation of light filter 4.

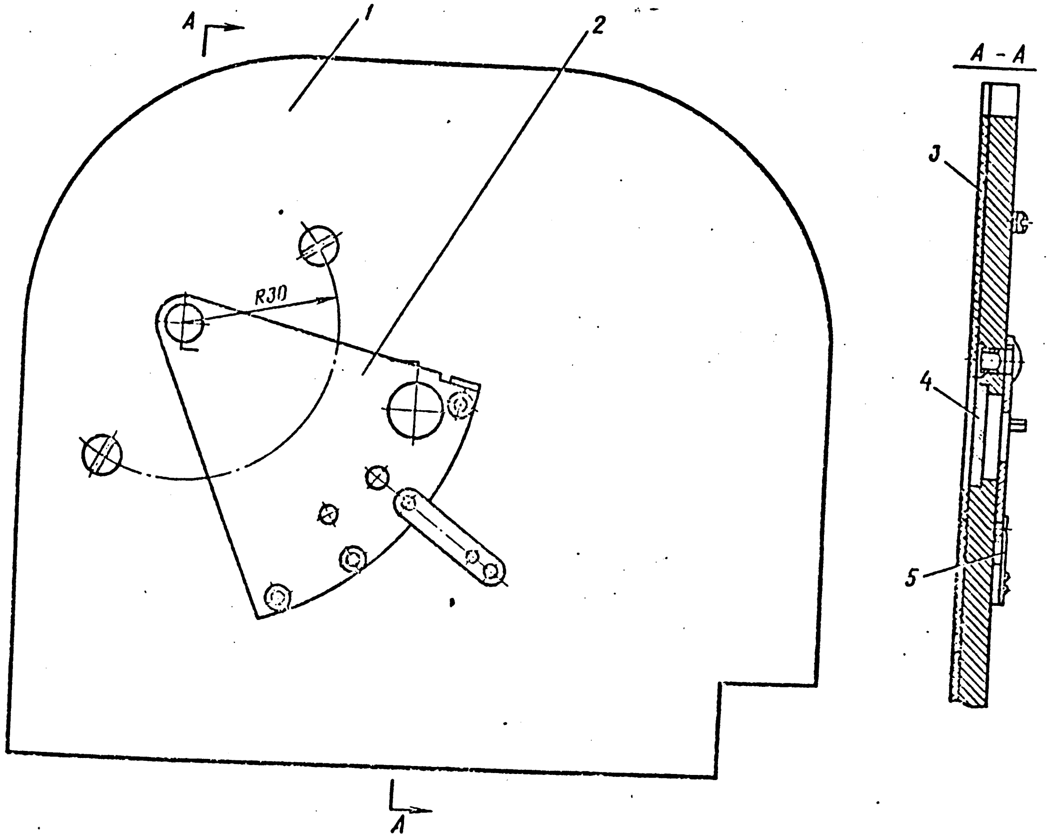

FIG.113. DIAPHRAGM
1 - base; 2 - sector; 3 - gasket; 4 - light filter; 5 - spring

Turning the sector and aligning one of its windows with the window in the base, it is possible to adjust the amount of light passing through the sight.

[redacted]

Adjustment of intensity of illumination improves the conditions of the sight adjustment. Spring 5 ensures locking of sector 2.

5.2.5. Electrical Circuitry

The sight electrical circuitry presented in (Fig.114) includes the control panel electrical devices, the image converter power pack, the electromagnet unit of the blind actuating mechanism, the reticles illumination unit and the eyepiece heater.

Arranged inside the control panel are tumbler switch B1 (TB2-1) of the power pack, day branch microswitch П2 (Д703) and night branch microswitch П1, signal lamps Л3 and Л4 (МН-26-0.12-1), potentiometer R22 (ПП3-12-1 kOм) in the night reticle illumination lamp circuit and potentiometer R23 (85±10% 25 B) in the day reticle illumination circuit.

The electrical circuitry operates as follows.

When the firing circuit switch B on the turret board is turned on, the voltage is fed to connector ШР 1/1,2 (shown in the diagram is the position of the switches during operation in the NIGHT mode). The following circuits are energized in this case: the circuit of signal lamp Л3 - ШР 1/1, B1/1,2, Л3, R24, ШР 1/2; the circuit of lamp Л2 (night reticle) - ШР 1/1, B1/1,2, Пр, block K1/7, П3/3,4, K1/6, R22, K1/9, Л2, K1/1, ШР 1/2; power pack circuit - ШР 1/1, B1/1, 2Пр, K1/7, C1, C2, Д1, Д2, Д3, Д4, R1, K1/1 and ШР 1/2.

To switch over to the DAY mode of operation tumbler B1 must be set in position OFF and button П2 must be depressed.

When tumbler B1 is switched off, contacts B1/1,2 break and contacts B1/3,4 are closed. Opening of contacts 1, 2 leads to breaking of lamp Л3 circuit and cutting off of the power pack. Closing of contacts 3, 4 prepares the circuit of lamp Л1.

When button DAY is depressed, the contacts of microswitch П2/3,4 are closed and current passes from ШР 1/1 to П2/3,4, K1/4, П4/1,2, M1, K1/1 and ШР 1/2, the blind actuating mechanism electromagnet places the mirror in the working position and closes the blind. Besides, microswitches П3 and П4 are switched over: П3 contacts 1, 2 are closed and contacts 3, 4 are opened, П4 contacts 3, 4 are closed and contacts 1, 2 are ~~closed.~~ OPENED?.

When contacts П3/3,4 are opened, the circuit of lamp Л2 is opened, and closing of its contacts 1, 2 leads to closing of lamp Л4 circuit-ШР 1/1, K1/8, П3/1,2, K1/5, П1/1,2, Л4, R25, ШР 1/2 and the circuit of lamp Л1 - ШР 1/1, K1/8, П3/1,2, K1/5, П1/1,2, B1/4,3, R23, R26, K1/10, Л1, K1/1, ШР 1/2.

When contacts П4/1,2 break, the supply circuit of electromagnet M1 is opened. The electromagnet winding is intended for short-time energizing.

Closing of contacts П4/3,4 prepares the supply circuit of the electric primers - the gun electric primer circuit.

To change over from the DAY to NIGHT mode of operation, set tumbler switch B1 to position ON and depress button П1 NIGHT.

When tumbler switch B1 is turned on, the circuits of lamp Л3 and the power pack are closed.

When button NIGHT is depressed, contacts П1/3,4 are closed and supply circuit of electromagnet M2: ШР 1/1, K1/8, П3/1,2, K1/5, П1/3,4, K1/3, M2, K1/1, ШР 1/2 is energized.

When electromagnet M2 operates, change-over switches П3 and П4 occupy the position, shown in the diagram.

Opening of contacts П4/3,4 opens the electric primer circuit.

Closed contacts П4/1,2 prepare the supply circuit of electromagnet M1.

For protection of the image converter from exposure to light of the gun firing, the gun may be fired only after the blind is closed.

When the sight operates in the NIGHT mode of operation, the electric primer circuit is open in contacts П4/3, 4 and runs as follows: B, KC, ШР 1/3, П2/1,2, K1/4, П4/1, 2, M1,

[redacted]

[redacted]

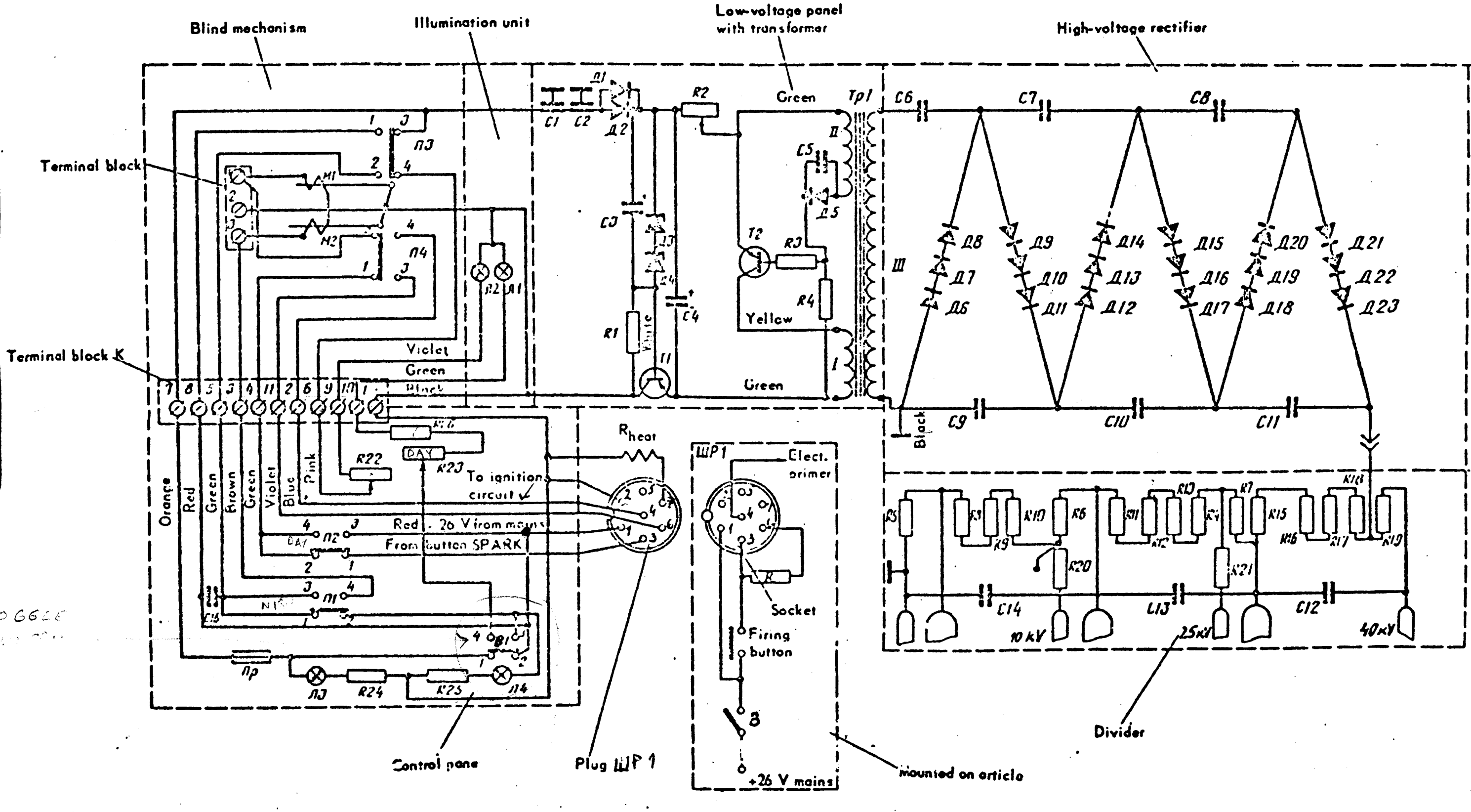
Blind mechanism
Illumination unit
Low-voltage panel with transformer
High-voltage rectifier
Terminal block
Terminal block K
Violet
Green
Black
Green
Yellow
Orange
Red
Green
Brown
Green
Violet
Blue
Pink
Black
R heat
To ignition circuit
Red - 26 V from mains
From button SPARK
ШР1
Elect. primer
Socket
Firing button
+26 V mains
10 kV
25 kV
40 kV
Divider
Control pane
Plug ШР 1
Mounted on article

FIG.114. SIGHT ELECTRICAL DIAGRAM

[redacted]

[redacted]

closed. The round is fired in this mode of operation as follows: when button 10 (Fig.84) is depressed on the right handle of the laying system control panel, the mains current is fed via limit resistor R to ШР 1/6, К1/11, П4/3,4, К1/2, ШР I/4 and through the electric primer to the frame.

To restore the NIGHT operating mode each time the gun is fired, it is necessary to depress button 11 (Fig.97) NIGHT (microswitch П1 on the sight control panel).

In the DAY operating mode contacts П4/3,4 are closed and the electric primer circuit is closed when gun firing button 10 (Fig.84) is depressed. To protect the image converter from exposure to light, the electrical equipment has special circuits, consisting of capacitors (Fig.114) C12, C13 and C14 and resistors R20 and R21.

The eyepiece heater consists of spiral R27 made of nichrome wire having 0.25 mm-diameter (the spiral power is 0.25 W).

The spiral is connected with contacts ШР 1/2,7.

5.2.6. Wiper and Sight Glass Protective Shutter

The wiper is actuated by handle 23 (Fig.68). Protective shutter 19 is intended for protection of the sight glass from soiling with powder gases during ATGM launching.

Shutter 19 is lowered immediately before launching of missile 9М14М by depressing pedal 25.

To leave the shutter closed, a slot is provided in the lower portion of the bracket groove; the slot is used to retain pedal 25. When the pedal is brought out from the slot, a spring returns the shutter to the initial position.

5.2.7. Care of Sight

Care of the sight consists in regular cleaning it of dust and dirt, preparing the mechanisms for the day and night operation, checking of fitness of the desiccators and replacing them in case of necessity or in reconditioning of silica gel.

Preparing Sight for Daytime Operation

Make sure the sight controls are in the initial position:

- electric trigger switch 17 (Fig.115) and power pack switch 10 (Fig.97) are OFF;
- blind handle 15 - in position CLOSED;
- sight protective shutter 19 (Fig.68) is open;
- light filter knob 16 (Fig.97) is in position НС-12;
- potentiometer knobs 8 and 13 are turned counterclockwise until stop.

Set electric trigger switch 17 (Fig.115) in position ON, this must be accompanied with green signal lamp 25 (Fig.97) lighting up on the sight control panel.

Set headrest 24 in the convenient position.

Rotating the ring of eyepiece 23, obtain the sharp image.

Rotating knob 8, adjust normal lighting of the sight day branch reticle.

Set temperature correction handle 4 to the necessary temperature range as indicated below:

"-20" - for temperatures below $-10^{\circ}C$;
"0" - for temperatures from -10 to $+10^{\circ}C$;
"+20" - for temperatures above $+10^{\circ}C$.

If the temperature is low, switch on heating of the protective glass by means of switch 15 (Fig.115) GLASS HEATING (ОБОГРЕВ СТЕКЛА) on the turret board and eyepiece heating by the switch on box 17 (Fig.11), controlling heating of troop compartment left side devices ТШПО-170.

[redacted]

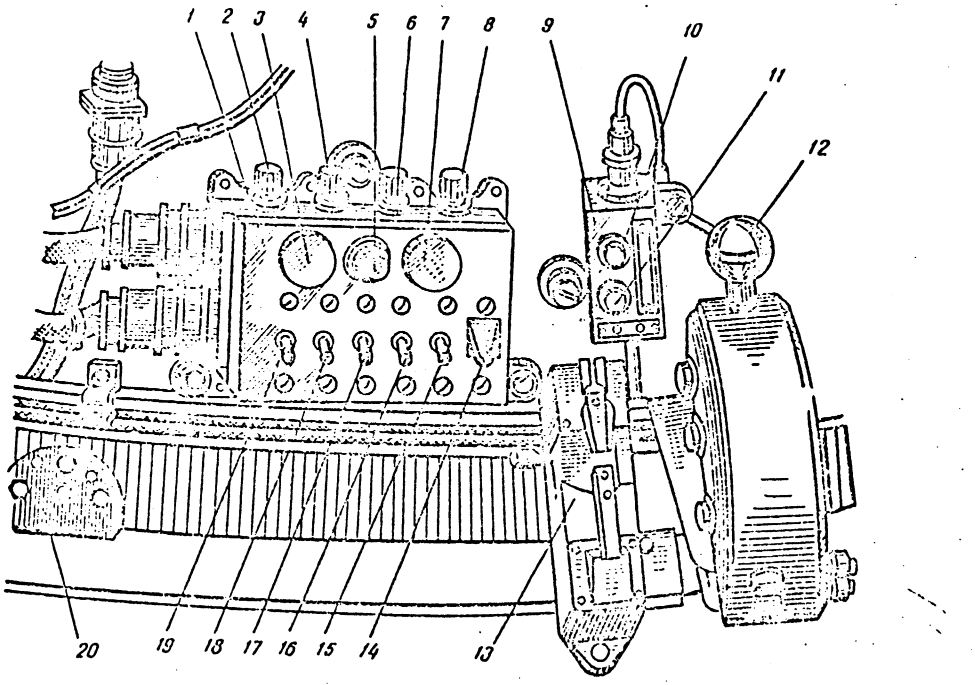

FIG. 115. TURRET DISTRIBUTING AND SIGNAL BOARDS

1 - turret board; 2 - 10-A fuse of gun electric primer system; 3 - conveyer start button; 4 - 10-A fuse of machine gun electric trigger circuit; 5 - 10-A fuse of lighting circuit; 6 - 10-A fuse of loading mechanism; 7 - button of loading mechanism levers lowering; 8 - 20-A fuse of elevation drive circuit; 9 - signal board; 10 - loading mechanism ON signal lamp; 11 - laying drive ON signal lamp; 12 - turret lock; 13 - gun stand-by electric trigger; 14 - loading mechanism switch; 15 - sight glass heating switch; 16 - TBHO-2 headlight switch; 17 - gun and machine gun electric trigger circuit switch; 18 - laying drive switch; 19 - blower switch; 20 - stopper for replacement of balls in turret race

Preparing Sight for Operation at Night

Make sure all controls are in the initial position as indicated above.

Set trigger switch 17 (Fig.115) in position ON, this must be accomplished by lighting up of green lamp 25 (Fig.97).

Depress button 11 NIGHT, green lamp 25 must go out.

Set power pack switch 10 to position ON, red lamp 37 must go on.

Shift blind handle 15 to position OPEN.

Observing through the sight and operating light filter knob 16, set the filter corresponding to best visibility of the terrain.

Rotating the ring of eyepiece 23, obtain clear image.

Rotating knob 13, adjust normal illumination of the night reticle (avoiding excessive brightness).

In case of sharp temperature change perform focusing of the objective. For this purpose unscrew the cover of focusing adjustment mechanism 17 and, observing through eyepiece 23, rotate the shaft in one or other direction by a screwdriver until clear image is obtained.

[redacted]

[redacted]

Turn out nine screws attaching rear cover of protective cap 20 (Fig.68) of the sight and remove the cover.

Unscrew the cover of aviation cartridge 3 (Fig.97).

Inspect silica gel colour through protective glasses of two desiccators 38 and one desiccator in front part. The colour must be blue. Replace the desiccators if the colour is pink.

Unscrew in turn the desiccator covers by a screwdriver and replace the desiccators (sleeves with silica gel) with the new ones from the SPTA set.

Screw up the desiccator covers.

Screw up the cover of the aviation cartridge.

Install in position the protective cap rear cover.

If the sleeves with serviceable silica gel are not available, screw up covers into the desiccators, screw in the aviation cartridge cover and start reconditioning of silica gel. Thereafter, install the sleeves with reconditioned silica gel in position.

Procedure of silica gel reconditioning is the following:

- place the sleeves with pink silica gel in a clean metal vessel or on a metal sheet and place in electric drier or thermostat;
- adjust the temperature to about 105°C;
- calcinate the sleeves until silica gel acquires blue colour;
- cool down the calcinated sleeves in the electric drier or thermostat;
- put the desiccators in position.

5.2.8. Order of Checking and Adjustment of Sighting Lines of Day and Night Branches

Install the vehicle on a level ground.

Prepare the sight for operation in the DAY mode, as indicated above. Set temperature correction handle to "+20".

Install the sight outer spare diaphragm in front of sight protective glass 22 (Fig.68) The diaphragm must be adjusted to the minimum possible light orifice, which allows observation of the terrain through the day branch.

Turn knob 16 (Fig.97) so that inscription "HC-12" provided on handle 16 faces the operator.

Switch on the sight power pack, for this turn switch 10 on, green lamp 25 must light u

Depress NIGHT mode of operation button 11, green lamp 25 must go out.

Open the sight blind by setting handle 15 in position OPEN. Make sure that the convert operation is normal by absence of the image distortion and good intensity of the screen gl If necessary, operate light filter knob 16 to obtain visibility of the terrain with the screen glowing not brightly.

Turn knob 13 so that the night reticle is illuminated well.

Operating the elevating and traversing mechanisms aim the apex of the night reticle upper inverted V-mark on a clear-cut landmark.

Set handle 15 in position CLOSED. Depress DAY mode of operation button 9 to switch ov the sight to the day branch. Turn power pack switch 10 off.

Rotating knob 8 obtain the required illumination of the day reticle.

The apex of the day reticle upper inverted V-mark must be accurately aligned with the point at which the night reticle inverted V-mark apex is aimed.

In case of misalignment, perform the adjustment as follows:

[redacted]

[redacted]

securing cover 39 and remove it;

-rotating the azimuth adjustment splined shaft displace the day reticle upper inverted V-mark until it is aligned with the vertical plane, passing through the aiming point;

- install cover 40 in position;
- remove vision device ТНПО-170 installed to the right of the sight;
- using a screwdriver, loosen the screw of temperature correction handle 4 axle;
- insert the screwdriver in the slot of axle 7 (Fig.103) and, rotating the latter, align the apex of the upper inverted V-mark with the aiming point in vertical plane;
- set handle 4 (Fig.97) to "0" and tighten the screw;
- remove the outer diaphragm;
- perform adjustment of the sight lines of sight as indicated below.

5.2.9. Order of Adjustment of Sight with the Gun

Glue the threads to the notches on the gun barrel muzzle, open the breechblock and insert the diopter tube in the chamber.

TEMP

Set handle 4 (Fig.97) in position "0" at any ambient temperature.

Prepare the sight for operation in the DAY mode, as described above.

Choose a clear-cut landmark at a distance of 800 m from the vehicle.

Align the crosshairs on the muzzle with the selected point on the landmark (lay the gun from below and from left to right). Check if the sight scale upper crosshairs is aligned with the aiming point of the crosshairs on the muzzle face. If it is not so, perform the adjustment as follows:

- insert a screwdriver in the slot of axle of azimuth adjustment mechanism 19 and, rotating the axle, align the reticle upper crosshairs with the aiming point in horizontal plane;
- insert the screwdriver in the slot of axle of elevation adjustment mechanism 21 and, turning the axle, align the upper crosshairs with the aiming point in vertical plane.

If the adjustment is performed at night, the landmark must be illuminated.

In case a clear-cut landmark is not available, perform the adjustment using a testing target. The difference in the procedure in this case consists in the following:

- install the target at a distance of 20 m from the muzzle, perpendicular to the barrel bore axis, check the correctness of the target installation by aligning the sight crosshairs with the horizontal line on the target and traversing the turret make sure that the crosshairs does not leave the horizontal line.
- aim the muzzle crosshairs with the cross bearing inscription "2А28" (Fig.100), in this case the gun angle of elevation must be "0";
- observing through the sight make sure that the reticle upper crosshairs is aligned with the cross bearing inscription "1ПН22М1" on the testing target. If they are not aligned, perform the adjustment as described in the previous case.

5.3. VISION DEVICE ТКН-3Б

5.3.1. Purpose

The commander's vision device is intended for observation of the terrain, determination of range to the targets, target designation and fire adjustment.

The set of device ТКН-3Б includes the vision device, spotlight ОУ-3ГА2, spare parts and accessories.

The binocular periscopic combination device ensures observation both in daytime and at night.

The device consists of body 4 (Fig.116), head 1 with the head prism, the image converter secured on the front cover of the device body, H.V. power pack mounted on cover 7, the eyepiece unit, the controls and headrest.

[redacted]

[redacted]

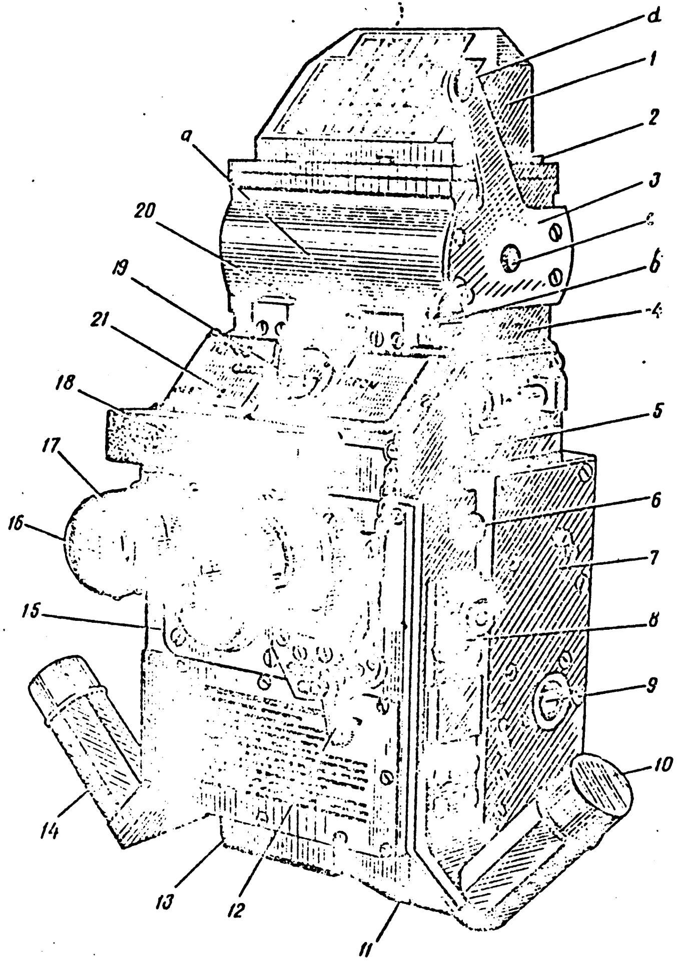

FIG. 116. VISION DEVICE TKH-3Б

1 - head; 2 - head fastening screw; 3 - strip with lever; 4 - device body; 5 - diaphragm handle; 6 - nipple; 7 - power pack panel cover; 8 - hinged mirror handle; 9 - plug; 10 - button in grip; 11 - plug connector; 12 - lock handle; 13 - switch guard; 14 - device grip; 15 - eyepiece plate; 16 - eyepiece; 17 - eyeshield; 18 - headrest; 19.- blind handle; 20 - stop; 21 - cover; a - cylindrical surface; b - slot; c - hole for trunnions; d - lever

[redacted]

[redacted]

The device optical system (Fig.117) consists of night and day branches having a number of common elements - head prism 1, mirror 10, diamond-shaped prism 11 and eyepieces 12.

The night branch of the optical system includes head prism 1 altering the rays travel 90°, objective 2 focusing the rays on the image convertor photocathode, light filter 3, image convertor 4 (type У-31А) converting the invisible image into visible one, protective glass 5, mirror 6 altering the direction of rays after the image convertor by 180°, first lenses 7 of the objective, prism 8, objective second lenses 9, mirror 10 altering the rays travel 90°, diamond-shaped prisms 11 and the eyepieces. Arranged above the image convertor are the movable and fixed blinds.

The image converter of the device is identical in design and operation to the sight image converter. The difference is that the converter used here has two chambers compared with three-chamber image convertor of the sight and that it converts the invisible image projected by the infrared rays into visible image.

The image converter operates as follows. The infrared rays (wavelength 0.8-1 μ), generated by spotlight ОУ-3ГА2, are reflected from the target and pass through head prism 1, night branch objective 2. The infrared image of the target is projected in the objective focal plane. Then the rays pass through light filter 3 and fall on the image convertor photocathode. Under action of infrared rays the photocathode emits electrons, the amount of which is proportional to the intensity of the beam energy. The electrons in the first chamber are driven by the electrostatic field forces to the positively charged screen, which starts to glow. The screen light image acts on the second chamber photocathode and the latter also emits electrons, but in greater amount. Falling on the last screen of the image convertor the flow of the electrons makes it glow and a visible image of the target appears on the screen, the image may be viewed through the eyepieces.

In case nocturnal lighting is sufficient, the night branch may be operated without illumination of the terrain by the spotlight.

The day branch of the optical system consists of head prism 1, objective 13 (the image is projected in the objective focal plane on the collecting lens), prism 14 turning the rays by 90°, collecting lens 15, collecting lens 16 with reticle, mirror 17 deflecting the rays 90°, first lenses 18 of the relay optical system, second lenses 19 of the relay optical system, mirror 10, diamond-shaped prism 11 and eyepiece 12.

The day system is binocular. The difference of the system branches is that the right-hand branch collecting lens has a reticle (Fig.118). The reticle deflection scale permits to determine angular dimensions of the observed objects and thus to find out approximate ranges to them, if their dimensions are known.

The value of the deflection scale small divisions is 0-04, and large division value, 0-08 (mils).

Marked below the deflection scale on the reticle is the range scale for determination of ranges to 2.7-m high targets (average height of armoured objects).

The method of range determination is the same as that used in the sight range scale.

5.3.3. Electrical Circuitry

The electrical circuitry supplies the image converter with voltages of +15.000 V and -15.000 V. Design and principle of action of the device night branch electrical circuitry are similar to those of the sight. The design and principle of action of the power pack are the same as in sight 1ПН22М1.

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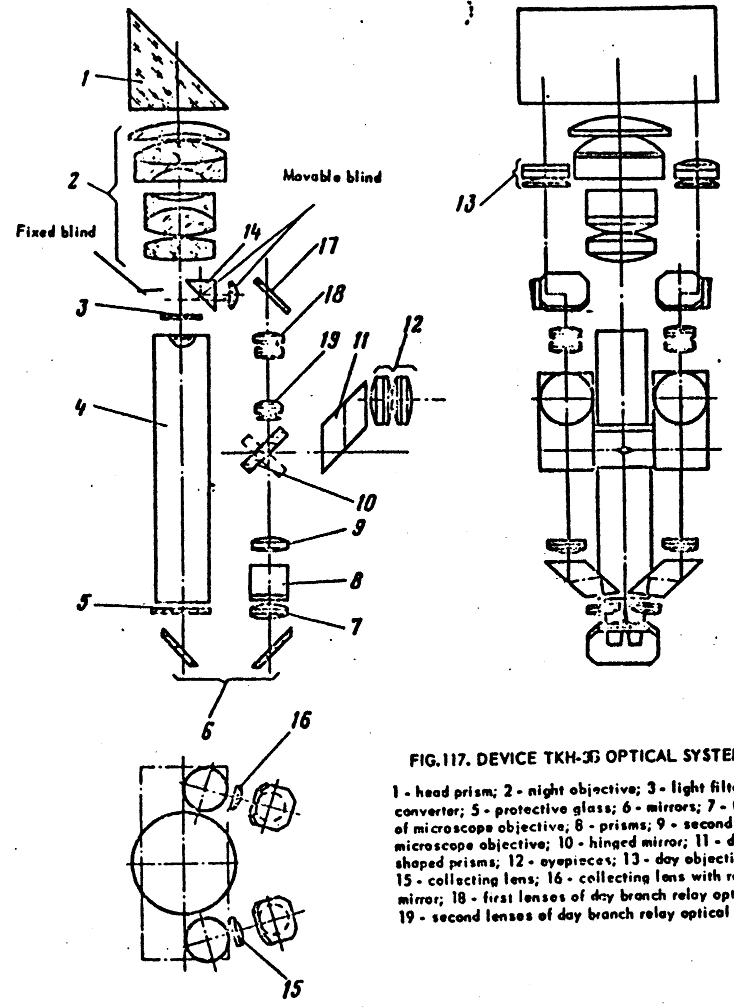
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FIG. 117. DEVICE TKH-3G OPTICAL SYSTEM

1 - head prism; 2 - night objective; 3 - light filter; 4 - image converter; 5 - protective glass; 6 - mirrors; 7 - first lenses of microscope objective; 8 - prisms; 9 - second lenses of microscope objective; 10 - hinged mirror; 11 - diamond-shaped prisms; 12 - eyepieces; 13 - day objective; 14 - prism; 15 - collecting lens; 16 - collecting lens with reticle; 17 - mirror; 18 - first lenses of day branch relay optical system; 19 - second lenses of day branch relay optical system

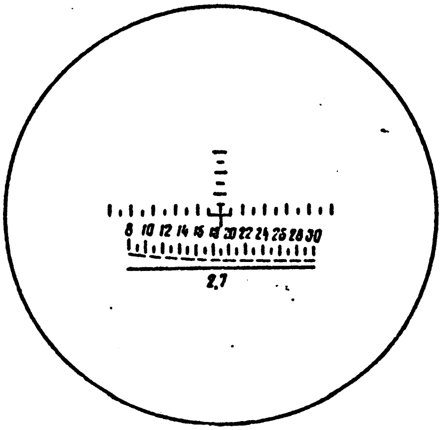
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FIG. 118. VIEW OF DAY BRANCH RETICLE

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Head 1 (Fig.116) is secured to device body 4 by means of screws 2. Arranged in the head is the head prism.

Intricately-shaped body 4 houses all units and parts of the device.

The body upper part has convex cylindrical surface "a", which rests on concave surface of flange 21 (Fig.17), secured from below to head 4 in the commander's hatch door. Flange 21 has two trunnions fitted in hole "c" (Fig.116) on the side surfaces of strips 3 secured from both sides to the device body. In the vehicle the device is protected by the head armour shield with a protective front glass, equipped with electric heating system and air-liquid cleaning system.

Right strip 3 has slot "b" for locking the device in the vertical plane and lever "d" for connection with the spotlight.

Attached in the body upper part under cover 21 is the blind actuating mechanism whose handle 19 protrudes outside.

Eyepiece plate 15 is secured in the device body middle part. The right-hand side wall carries diaphragm handle 5 and hinged mirror handle 8. The body has on its outer surface two nipples 6 used for blowing the device with dry air, plug connector 11 with a protective cap, power pack switch under guard 13 and a desiccator.

Mounted on eyepiece plate 15 are the second lenses of the day branch relay optical system, hinged mirror assembly, second lenses of night branch relay optical system, first lenses of night branch relay optical system with prisms and the eyepiece assembly.

The eyepiece assemtly is furnished with toothed sectors for adjustment of the eyepieces according to the eye base. The adjusted position of the eyepieces is fixed by means of lock handle 12.

The eyepiece lenses may be displaced along the axis during diopter adjustment by means of knurled rings. The eyepiece eyeshields 17 are secured with spring-loaded retainers.

In winter the eyepieces are heated by means of a removable heater. To install the heater remove the eyeshields and mount the heaters instead, securing them with the retainers. The heaters are supplied through a cord with a plug inserted in the device heating system receptacle.

The blind actuating mechanism is intended for partial or complete closing of the image convertor photocathode. It consists of a blind (a rectangular plastic plate), which is hinge-joined to the control linkage and bracket fork.

As handle 19 is turned, the bracket is displaced and the blind opens or closes the image converter photocathode depending on the handle position. Inscriptions OPEN (OTKP.) and CLOSED (3AKP.) are provided under the handle.

Partial closing of the blind is used to reduce the device exposure to light of a foreign source.

The diaphragm is intended to reduce intensity of illumination of the image converter photocathode during checking of the device night branch in daytime. It is installed in the night branch objective.

The iris diaphragm has round shape and consists of a set of movable metal plates (blades), which can be moved to vary the diameter of the central aperture, through which light passes to the photocathode.

The diaphragm is controlled by handle 5 through a linkage consisting of two bevel and two spur gears and shafts. Inscriptions OPEN (OTKP.) and CLOSE (3AKP.) are written near the handle.

The hinged mirror assembly serves to switch over the day and night branches. It consists of a mirror, installed in the mounting rotating in bearings. The mounting is connected with handle 8 by a shaft. The shaft has a cam which actuates H.V. power pack microswitch through a push rod.

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Marked on handle 8 are letters Д (day) and Н (night). position Д the mirror is turned in the working position and the microswitch is turned off, with the handle set in position Н the mirror is turned 90° and the microswitch is cut in.

Grips 14 serve for aiming of the device. The spotlight switch button is at the top of the R.H. grip.

The desiccator serves to prevent sweating of the device internal glasses. The design and principle of action of the desiccators are identical to those of the sight.

5.3.5. Spotlight ОУ-3ГА2

Spotlight ОУ-3ГА2 serves as a source of illumination of terrain. In the working position it is installed on the commander's hatch door and is connected by rod 9 (Fig.119) with device ТКН-3Б.

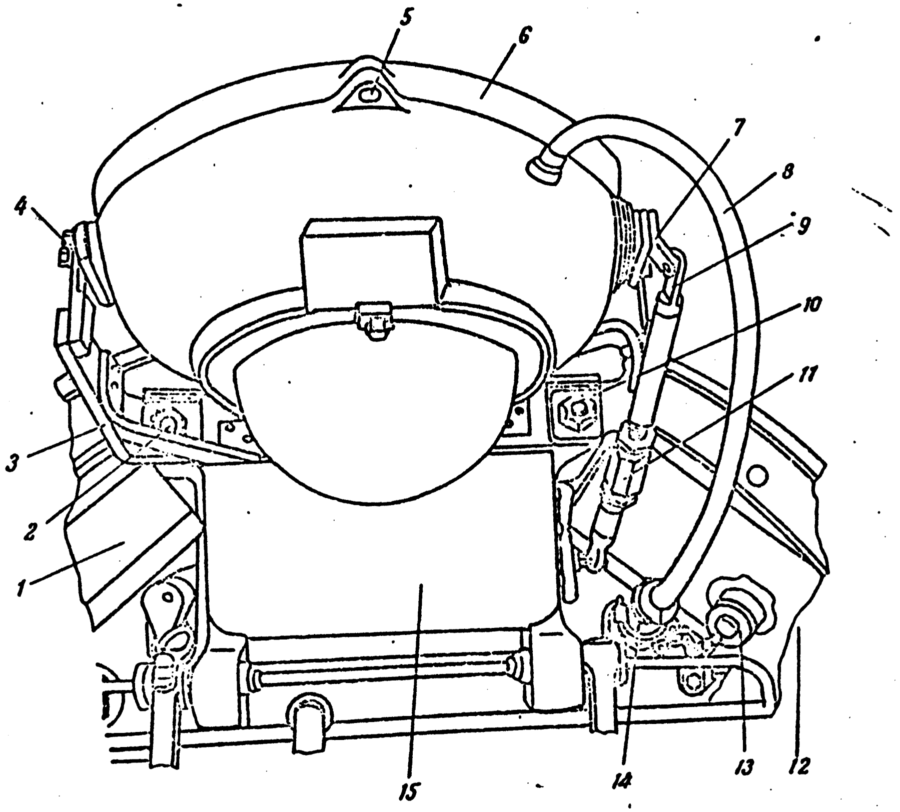

FIG.119. INSTALLATION OF SPOTLIGHT ОУ-3ГА2

1, 12 - vision devices ТНПО-170; 2, 10 - pins with locks; 3 - bracket; 4 - bolt; 5 - screw; 6 - front frame with infrared filter; 7 - lever; 8 - cable; 9 - rod; 11 - turnbuckle; 13 - stopper; 14 - plug connector; 15 - device ТКН-3Б

[redacted]

body, holder 14 with lamp 22, reflector 7, infrared filter 29 and protective cover 1. Supply cable 8 (Fig.119), runs to the spotlight from plug connector 14 located on the commander's hatch door.

5.3.6. Operation of Device TKH-3Б

Adjustment of Optical Axes of Vision Device and Spotlight

The adjustment is performed at night in the following order:

- place the vehicle on a level ground;
- turn on device TKH-3Б and the spotlight;
- loosen the locknuts of turnbuckle 11 (Fig.119) on rod 9;
- choose a landmark at a distance of 400-450 m from the vehicle;
- looking through the device at the middle of the landmark, align the center of the light spot of the spotlight with the point at which the vision device is directed; to adjust the spotlight in azimuth loosen four bolts 4 and move the spotlight body in the required direction; elevation adjustment of the spotlight is performed using turnbuckle 11;
- tighten up the locknuts and bolts.

Operation of Device at Night

Make sure the supply cable is connected to device plug connector.

Place hinged mirror handle 8 (Fig.116) in position H (night).

Turn on the switch located in the device lower part under guard 13.

Shift blind handle 19 to position OPEN.

Turn diaphragm handle 5 towards position OPEN.

Adjust the eyepieces to the base of eyes and to the required diopter setting.

If bright illumination of terrain interferes with observation, operate handle 5 or 19 to reduce the image brightness.

Operation of Device in Daytime

Set mirror handle 8 in position Д (day).

The blind and diaphragm must be closed (handles 5 and 19, in position CLOSED).

In winter fit the heater on the eyepieces and switch it on.

5.3.7. Care of Device

During nighttime operation avoid exposure of the device to direct visible light, using the blind and diaphragm for this purpose.

As a rule, the diaphragm and the blind must be closed and hinged mirror handle 8 must be in position Д (day). Use the night branch only when necessary.

Do not allow icing and sweating of the external glasses and wipe them with flannel cloth as soon as the situation allows.

Periodically check the desiccators for condition and replace them when sweating of internal glasses is detected or when the desiccators lose their absorbing properties.

Condition of silica gel is determined by its colour. Reconditioning of silica gel is carried out by means of calcinating it until it acquires blue colour, reconditioning may be done any number of times.

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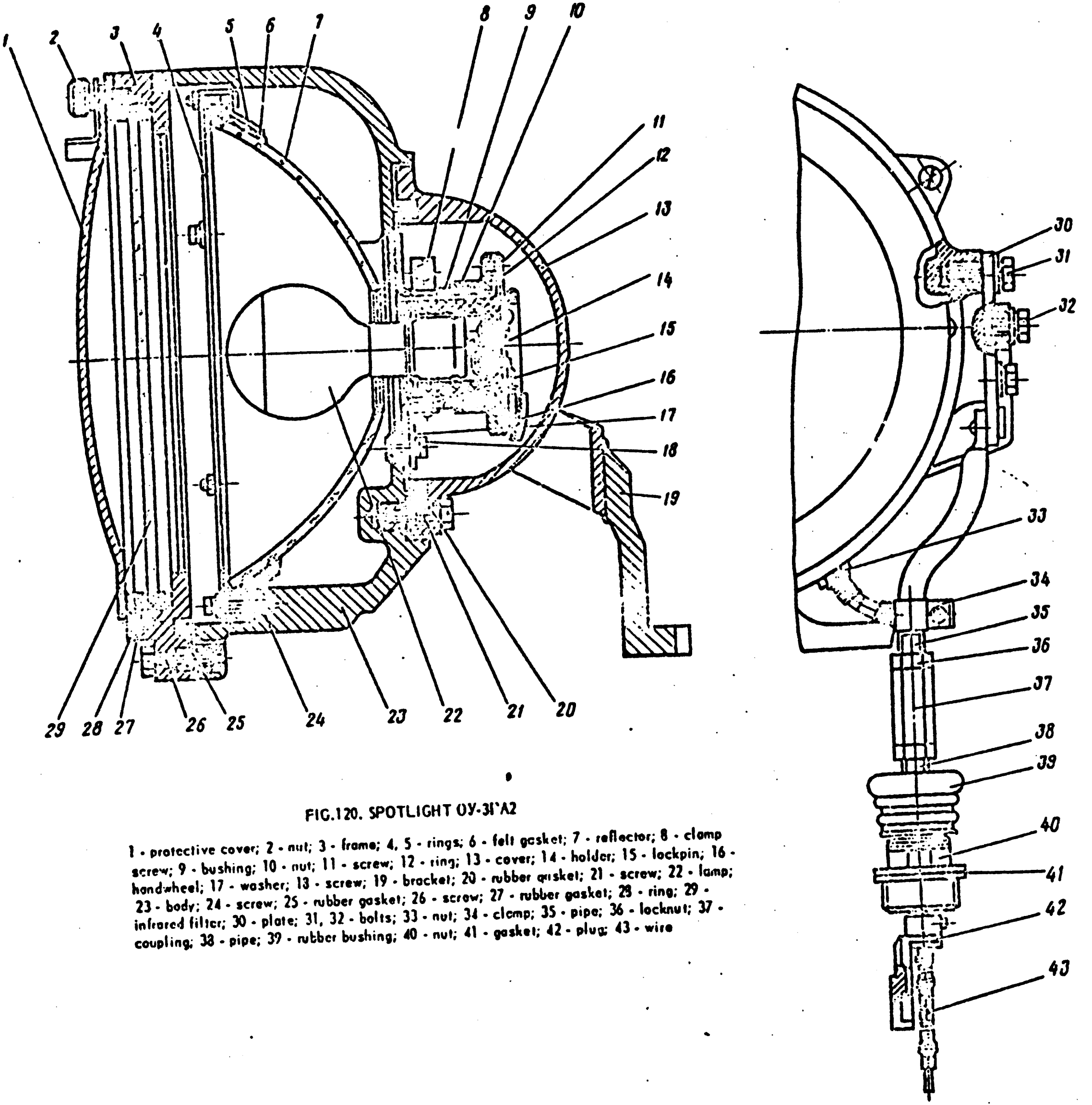
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FIG.120. SPOTLIGHT ОУ-3I`A2

1 - protective cover; 2 - nut; 3 - frame; 4, 5 - rings; 6 - felt gasket; 7 - reflector; 8 - clamp screw; 9 - bushing; 10 - nut; 11 - screw; 12 - ring; 13 - cover; 14 - holder; 15 - lockpin; 16 - handwheel; 17 - washer; 13 - screw; 19 - bracket; 20 - rubber gasket; 21 - screw; 22 - lamp; 23 - body; 24 - screw; 25 - rubber gasket; 26 - screw; 27 - rubber gasket; 28 - ring; 29 - infrared filter; 30 - plate; 31, 32 - bolts; 33 - nut; 34 - clamp; 35 - pipe; 36 - locknut; 37 - coupling; 38 - pipe; 39 - rubber bushing; 40 - nut; 41 - gasket; 42 - plug; 43 - wire

[redacted]

With tumbler switch on and hinged mirror handle 8 in position H, specific sound of operating power pack is not heard	Power pack is out of order	Remove the device and send for repair
Power pack operation is normal (specific sound is heard), but green background is not visible in device eyepieces	Image converter is inoperative	Remove the device and send for repair
Greenish background is visible on device screen, but images of objects and terrain are absent	Short or open circuit in spotlight supply wire	Check and correct the fault
	Burnt out lamp of spotlight ОУ-3ГА2	Replace lamp
Close objects are not clear or not visible at all	Misalignment of optical axes of spotlight and vision device	Check and adjust alignment of optical axes (see Adjustment of Optical Axes of Vision Device and Spotlight)
Dark spots in device field of vision	Damage to image converter by exposure to pointed light sources	Replace image converter in workshop
	Penetration of moisture in device	Blow off with dry air. Replace desiccant.
	General exposure of image converter to light	Do not operate the device until space-charge effect disappears. Replace image converter, if after two-three days image converter does not restore its properties
After switching on spotlight ОУ-3ГА2 bright spots are visible through the filter	Infrared filter film is faulty	Replace filter
Image is blurred and not clear	External surface of prisms dirty	Wipe with clean flannel cloth
	Partial misalignment of spotlight and device optical axes	Align optical axes
	High voltage value is below 13 kV	Check output voltage by a kilovoltmeter in workshop. If required, replace power pack
Loose attachment of upper prism head	Loose attaching screws	Tighten up
Prism is fractured or cracked	Mechanical damage	Replace upper head

[redacted]

The driver's vision device serves for observation of the road when driving vehicle at night.

The device set (Fig.121) includes vision device 17, H.V. power pack 4, headlight ФГ-125 with infrared filter, holder 15 with heater and diaphragm 6.

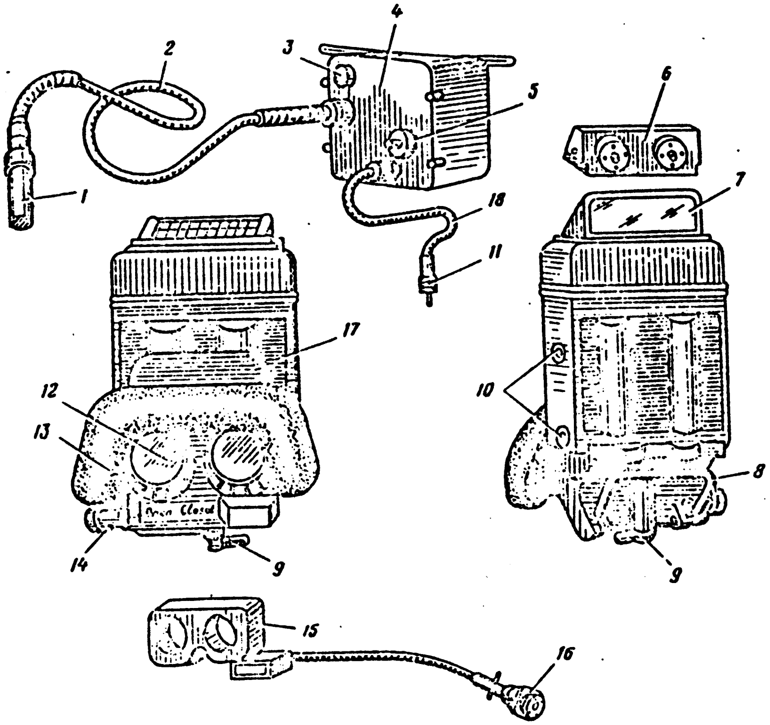

FIG.121. DRIVER'S NIGHT VISION DEVICE TBHO-2

1 - protective cap of H.V. cable plug; 2 - H.V. cable; 3 - fuse; 4 - power pack; 5 - power pack switch; 6 - diaphragm; 7 - prism protective glass; 8 - device handle; 9 - blind handle; 10 - device fastening holes; 11 - connector plug for connection to vehicle mains; 12 - eyepieces; 13 - headrest; 14 - H.V. lead-in; 15 - holder with heater; 16 - plug connector; 17 - vision device; 18 - L.V. cable

5.4.2. Design

Device TBHO-2 is a binocular periscopic device equipped with heating system of the head prism and eyepieces. It consists of the optical system with image converters, H.V. lead-in, body, head, screening device and headrest.

5.4.3. Electron-Optical System

The device electron-optical system consists of two parallel branches (Fig.122). It includes upper prism 2, two objectives 3, two image convertors 5, two lower prisms 18 and two eyepieces 12.

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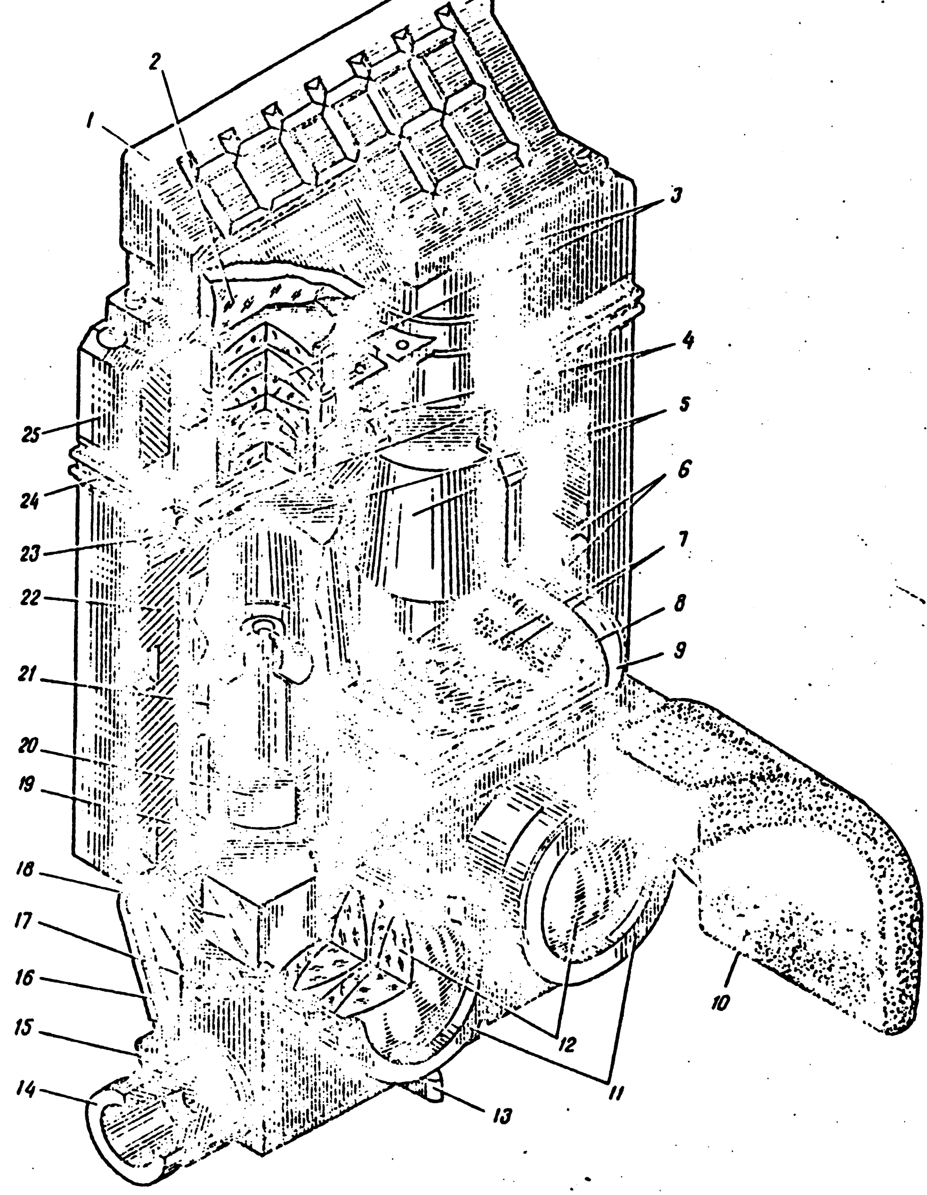
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FIG. 122. ELECTRON-OPTICAL SYSTEM OF DEVICE TBHO-2

1 - head; 2 - upper prism; 3 - objectives; 4 - blinds; 5 - image converters; 6 - rubber caps; 7 - H.V. wires; 8 - T-piece; 9 - cover of H.V. part; 10 - headrest; 11 - eyeshields; 12 - eyepieces; 13 - blind handle; 14 - protective plug; 15 - union nut; 16 - handle for removal of device; 17 - body lower part; 18 - lower prism; 19 - clamping nut; 20 - screen; 21 - anode cylinder; 22 - body middle part; 23 - base of blind; 24 - rubber cup; 25 - body upper part

[redacted]

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High voltage is supplied to the image converters through H.V.

from power pack 4.

The design and principle of action of TBHO-2 electron-optical system are similar to those of the night branch of commander's device TKH-3Б described above.

The device is furnished with headrest 13 and the eyepieces with eyeshields to facilitate observation and to protect the observer against injury.

The photocathodes of the image converters are equipped with the screening device (blinds), which close the photocathodes so that exposure to light in the upper part of the device field of vision is eliminated and at the same time it is possible to observe the road and terrain images in the lower part of the field of vision. The blinds are controlled manually by handle 9.

The removable head is attached to the body with four screws. A glass plate coated with current conducting layer is cemented to the front surface of the upper prism located in the head.

The current conducting layer is fed with voltage through brass buses soldered to the edges of the plate.

A thermistor is mounted in the middle part of the prism, serving as the temperature pickup of the head prism.

Mounted on the head is a diaphragm, intended for limiting the amount of light passing into the device when checking its serviceability in daytime. Diaphragm 6 has two identical discs with holes. Turning of the disc adjusts the size of opening for passage of light and, thereby, the degree of lighting.

5.4.4. High-Voltage Power Pack BT-6-26

H.V. power pack is intended to convert the mains 26-30 V direct current to up to 18.000-V.direct current.

The power pack incorporates the vibrator, pulse transformer and kenotron. Besides, it includes switch, lamp with holder, capacitors, adjusting resistors and high-voltage cable. All the elements are arranged in the casing. The casing front panel carries lead-outs of H.V. cable 2 and L.V. cable 18, a window closed with the protective glass and switch 5 lever.

In the power pack the mains direct current is converted by the vibrator into pulsating current. Due to passage of pulsating current in transformer primary winding H.V. direct current is induced in its secondary winding, which is rectified in kenotron. Operation of kenotron is based on a thermal emission effect. The electrons fly from the kenotron cathode heated by H.V. current. Under action of positive half-cycle of the alternating voltage applied to the kenotron anode from the pulse transformer secondary winding, the electrons go from the cathode to anode, creating current in the image converter circuit. During the A.C. voltage negative half-cycle on the anode, the flow of electrons to the anode is stopped and no current flows in the external circuit. Thus, the kenotron passes current in one direction only. i.e. rectifies the latter.

The power pack is cut in by switch 5.

5.4.5. Headlight ФГ-125

Infrared headlight is intended for illumination of terrain. Design and principle of action of the light are identical to those of spotlight ОУ-3ГА2 described above.

The headlight is switched on by switch 16 (Fig.246) located on the driver's central panel.

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[redacted]

Device TBHO-2 may be mounted in the vehicle in two positions:

- in combat position in the well instead of the middle day vision device THП-170;
- in travelling position on the removable bracket, which is secured on the hull roof in front of the driver's hatch (Fig.123).

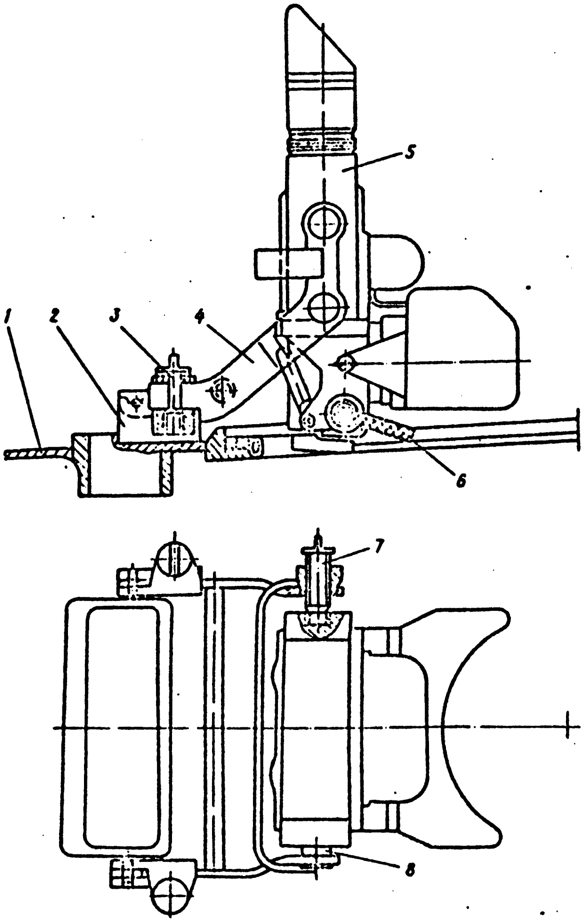

FIG. 123. DEVICE TBHO-2 IN TRAVELLING POSITION

1 - roof plate; 2, 4 - brackets; 3 - screw; 5 - device TBHO-2; 6 - H.V. cable; 7 - screw; 8 - axle

5.4.7. Checking the Device for Correct Installation

Checking of the device correct installation consists in alignment of its optical axis with the optical axis of head light ФГ-125. To adjust do the following:

- place the vehicle on a level ground;
- choose or post a reference point at a distance of 20 m from the vehicle. This reference point must be located on the continuation of the vehicle longitudinal axis;
- install device TBHO-2 in the well instead of the driver's middle device and connect a H.V. cable to it;
- turn on the power pack and R.H. headlight ФГ-125;

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- with the driver observing through the device, the vehicle commander turns the headlight to align its light spot with the base of the reference point;

- without disturbing the adjustment fix the headlight and check its alignment again;

- remove the optical element with blackout device from the L.H. headlight or from the headlight mounted on the turret and install instead the optical element with the infrared filter from the operational SPTA set;

- turn on the L.H. headlight (or turret-mounted headlight) fitted with infrared filter loosen its attaching nut and align its light spot with the reference point, located at a distance of 35 m from the vehicle on the continuation of its longitudinal axis. Fix the lig and check if the alignment is not disturbed;

- turn off the power pack and headlight.

5.4.8. Care of Device

Care of device TBHO-2 consists in wiping of the protective glasses and eyepieces of th device and the headlights with a clean flannel cloth and in regular checking of alignment of the optical axes of the device and headlights.

5.4.9. Probable Troubles of Device TBHO-2

Trouble	Cause	Remedy
With power pack switched on, specific sound of vibrator is not heard	Loss of contact in wire going from the mains to power pack	Check and repair
	Vibrator inoperative	Replace the vibrator with spare one
	Blown 10 A fuse on central panel	Replace fuse
When power pack is cut in, specific sound of the vibrator is heard, but greenish background is not visible in the device	Maladjusted working contacts of vibrator	Replace the vibrator with spare one
	Burnt lamp 12 V x 21 cd	Replace lamp
	Kenotron filament is burnt	Replace kenotron
	Bad insulation of H.V. cable or bad contact in connectors	Replace cable. Clean contact and tighten the nuts
	Open circuit in winding of pulse transformer	Send power pack for repair
Image is not clear enough	Dirt (moisture) on the inlet window or eyepiece.	Wipe with clean flannel cloth
	Disturbed alignment of light beam and device optical axis	Perform adjustment
	Headlight ФГ-125 is faulty	Repair the headlight
	Blown 10-A fuse in headlight circuit	Replace fuse
Power pack operates, but device is blinking or greenish background is absent	Moisture and dirt in H.V. connectors	Clean H.V. connectors
	Image converter is inoperative	Send device for repair
Greenish background is visible in eyepieces, but no	Blind or diaphragm closed	Open blind or diaphragm
	Headlight ФГ-125 is cut off	Cut in headlight

[redacted]

	Cause	Remedy
image is visible	Headlight supply wire is cut	Check wire and eliminate fault
	Headlight ФГ-125 lamp is burnt	Replace lamp
When headlight ФГ-125 is turned on, bright spots are visible through filter	Damaged infrared filter film	Replace filter

5.5. VISION DEVICES ТНПО-170

5.5.1. General

Installed in the vehicle are nineteen vision devices ТНПО-170, out of them: three devices in the driving compartment roof in front of the driver, two devices on both sides of device ТКН-3Б in the commander's hatch door, four devices for the operator in the turret roof, four devices on each side of the vehicle in the troop compartment roof and two devices in the rear doors. Besides, vision device ТНПО-350Б is available to provide observation for the driver when the vehicle is afloat.

5.5.2. Design of Vision Device ТНПО-170

Device ТНПО-170 (Fig.124) is a prismatic periscopic unit consisting of prisms 10 and 13 installed in body 12, and plug connector 7. The upper prism is secured by the cover, and the lower one, by bottom 8. Packing of the prisms in the body is provided by the hermetic compound and cups. The inlet and outlet surfaces of the prisms are protected with glasses 14 and 9 cemented to the prisms.

The troop compartment devices are arranged in the wells, welded into the hull roof near the sides. They are secured in the wells by means of the eccentric locks.

To remove the device, disconnect connector 7, turn levers 1 and 23 through 180°, pull eccentric shaft 5 and remove the device.

The devices mounted in the doors have cases 15 protecting outlet glasses 14 from dirt. To open the glass, raise the case by means of handle 22. The case is locked in open and closed positions by spring-loaded ball retainer 19 entering recesses on rod 20.

5.6. VISION DEVICE ТНПО-350Б.

Device ТНПО-350Б (Fig.124) is installed instead of ТНПО-170 middle vision device to ensure observation for the driver while moving with the splash panel raised when crossing water obstacles.

The main parts of the device are the housing upper and lower parts, three prisms 27, 29 and 30, cover and heating system plug connector 31. Heating is switched on by switch 32.

The main difference of device ТНПО-350Б from device ТНПО-170 consists in its greater periscopic height.

To facilitate mounting of the device in position, the housing lower part is made detachable. Both parts of the housing are joined together by lock 33. The device is secured in the well by the same eccentric clamp as device ТНПО-170.

5.7. VISION DEVICES HEATING SYSTEM

5.7.1. Components

The system (Fig.125) consists of two parts:

- a group of heaters automatically controlled by means of relay box КР-60 and temperature regulator РТС-27-3;

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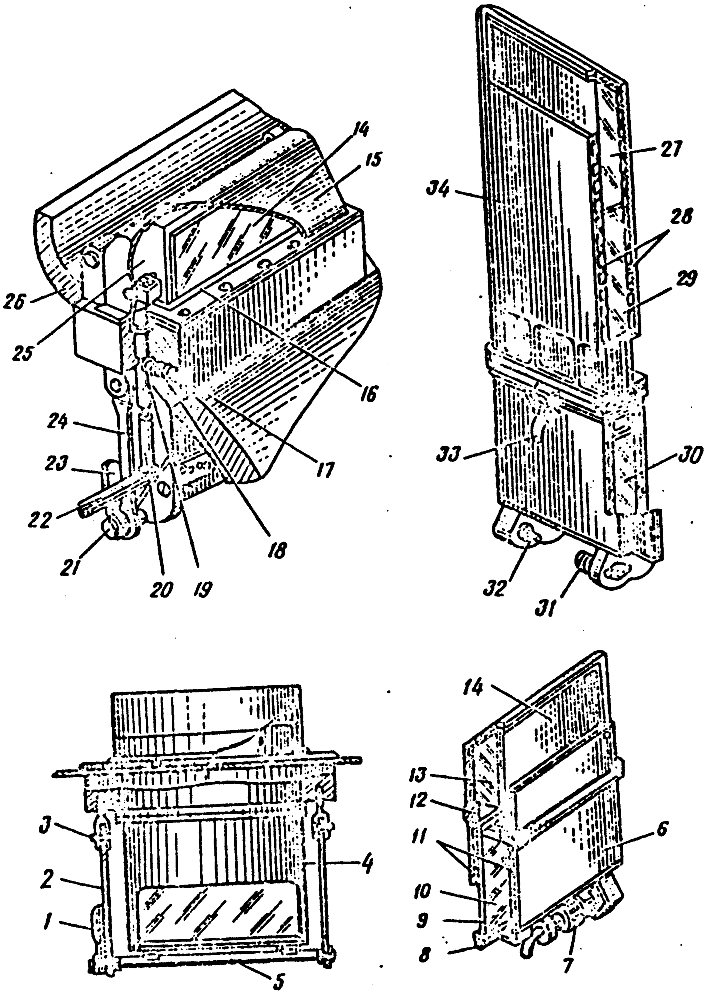
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FIG. 124. DAY VISION DEVICES ТНПО-170 AND ТНПО-350Б

1, 23 - levers; 2, 24 - tie rods; 3 - eye; 4, 6, 25 - vision devices ТНПО-170; 5, 21 - eccentric shafts; 7, 31 - plug connectors; 8 - bottom; 9, 14 - protective glasses; 10, 30 - lower prisms; 11, 28 - gaskets; 12 - device body; 13, 27 - upper prisms; 15 - protective case; 16 - packing; 17 - stopper; 18 - spring; 19 - retainer; 20 - rod; 22 - handle; 26 - door; 29 - intermediate prism; 32 - device ТНПО-350Б heater switch; 33 - lock; 34 - device ТНПО-350Б

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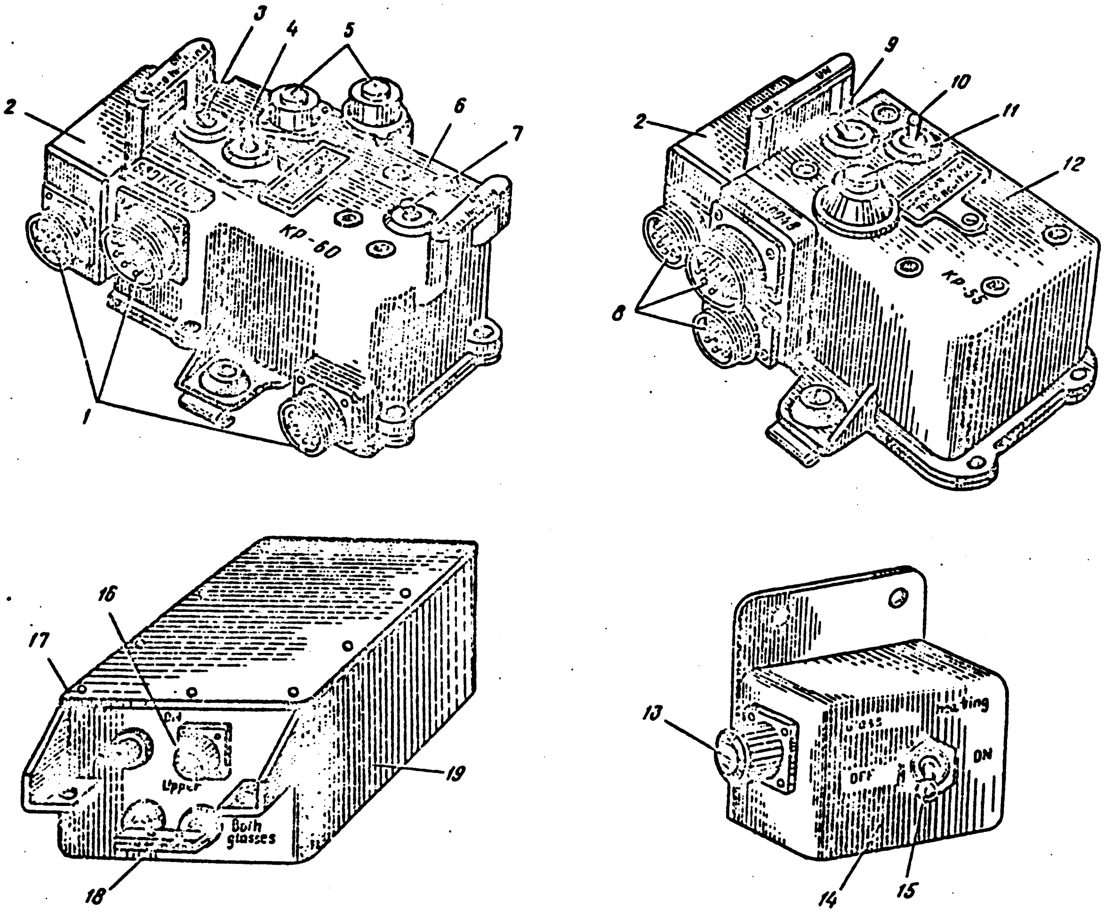

FIG. 125. VISION DEVICES HEATING SYSTEM

1 - box KP-60 plug connectors; 2 - temperature regulator; 3 - devices THIIO-170 heating system switch; 4 - change-over switch of devices THIIO-170 glasses heating system; 5 - signal light; 6 - troop compartment right side vision devices heating system box; 7 - firing port glasses heating system switch; 8 - box KP-55 plug connectors; 9 - heating system switch; 10 - glasses heating system change-over switch; 11 - signal light; 12 - driver's vision devices heating system box; 13 - signal light; 14 - device TKH-36 protective glass heating system box; 15 - device TKH-36 protective glass heating system switch; 16 - signal light; 17 - device THIIO-170 heating system switch; 18 - devices THПO-170 glasses heating system change-over switch; 19 - commander's devices heating system box

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The system automatic part includes the

- inlet and outlet windows of devices ТНПО-170;
- upper prism and eyepieces of device ТВНО-2;
- ТНПО-350Б lower prism;
- glasses of the driver's hood;
- eyepieces of device ТКН-3Б;
- sight 1ПН22М1 eyepiece.

Non-automatic part of the system includes the heaters of:

- glasses of firing ports of ball supports (heating is turned on by switch 4 on box КР-60);
- device ТКН-3Б protective glass (heating is turned on by switch 15 on heating system box 14);
- sight 1ПН22М1 protective glass (heating is turned on by switch 15 (Fig.115) on the turret board).

5.7.2. Heating System Control Circuitry

All the heaters in the control circuitry are subdivided into four independent groups.

A group of heaters of the troop compartment left side vision devices, including four left-side vision devices ТНПО-170 and one door-mounted vision device, four turret devices ТНПО-170, sight 1ПН22М1 heater and five glasses of the ball support firing ports. These heaters are controlled by relay box КР-60 installed in rear left corner of the troop compartment.

A group of heaters of troop compartment right side vision devices, including four devices ТНПО-170 installed on the vehicle right side, one door-mounted vision device and four firing port glasses of the same side. All heaters of this group are controlled by the relay box installed in the troop compartment right side.

A group of heaters of driver's vision devices, which include three devices ТНПО-170 (when afloat device ТНП-350Б and at night - device ТВНО-2 mounted instead of middle device ТНПО-170). In the travelling position, this group includes the heaters the driver's hood glasses.

The heaters of this group are controlled by relay box КР-55 installed in the hull left-hand bay.

A group of heaters of commander's vision devices including two devices ТНПО-170 and protective glass of device ТКН-3Б inlet window.

Heating of devices ТНПО-170 is turned on by switch 17 (Fig.125) installed on commander devices heating system box 19 and is controlled by regulator РТС-27-3. The protective glass heating element is turned on by switch 15 on heating system box 14 installed near device ТКН-3Б.

5.7.3. Design of Heaters and Equipment of the Heating System

The heaters of upper and lower prisms of devices ТНПО-170 are actually glass plates coated with current-conducting transparent stannic oxide layer. Soldered to the edges of the plates are copper buses for feeding mains voltage to the current-conducting layer.

For checking the temperature of the prisms heating installed in their middle are thermal resistors (thermistors) ТОС serving as temperature pickups.

Heaters of ТВНО-2 upper prism and ТНПО-350Б lower prism, protective glass of device ТКН-3Б, driver's protective hood glass and firing port glasses are also made as glass plates coated with current-conducting layer as on devices ТНПО-170.

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Thermistors TOC are included in the electrical circuit of heaters of device upper prism and eyepiece cell, vision device ТНПО-350Б lower prism and driver's protective hood front glass.

Heater of device ТНПО-350Б is connected to the circuit using the plug connector identical to that of device ТНПО-170.

In some devices ТВПО-170 thermistor TOC and regulating resistor СП-5 are cut in the electric circuit of temperature regulator PTC (main devices). Included in this group of devices are the rear devices in the troop compartment left and right row, driver's central vision device (or devices ТНПО-350Б, ТВНО-2), driver's protective hood front glass and commander's right-hand device.

The face side of relay box KP-60 mounts change-over switch 4 (Fig.125) with inscriptions LOWER, COMMON, UPPER, ТНПО HEATING (НИЗ, ОБЩ, ВЕРХ, ОБОГРЕВ ТНПО), heating system switch 3 with inscriptions ТНПО HEATING ON-OFF (ВЫКЛ.-ВКЛ., ОБОГРЕВ ТНПО), firing port glasses heating system switch 7 with inscriptions GLASS HEATING ON-OFF (ВЫКЛ.-ВКЛ., ОБОГРЕВ СТЕКОЛ), two signal lights 5 with lamps 26 V, 0.12 W.

Arranged in the housing are two contactors, a relay, two plug connectors, diodes and resistors.

Temperature regulator PTC-27-1 is attached to the box housing.

Relay box KP-55 carries on its face panel heating system switch 9 (АЗС-15) with inscriptions ON-OFF, two-pole change-over switch 10 with inscriptions LOWER, COMMON, UPPER, ТНПО HEATING, signal light 11 with lamp 26 V, 0.12 W.

Arranged in the housing are two contactors, an electromagnetic relay, two plug connectors diodes and resistors. Attached to the box housing is temperature regulator PTC-27-1.

Heating system box PTC-27-3 of the commander's vision devices includes temperature regulator PTC, two-pole change-over switch 18 with inscriptions UPPER, BOTH GLASSES, LOWER (ВЕРХНЕЕ, ОБА СТЕКЛА, НИЖНЕЕ), switch 17, signal light 16 with lamp 26 V, 0.12 W, an electromagnetic relay and plug connectors.

Temperature regulator PTC-27-1 is intended to automatically maintain the temperature at the inlet and outlet window glass surfaces of the vision devices. The regulator is composed of semiconductor triodes, resistors, capacitors, diodes and electromagnetic relay. The regulator is connected to the circuit by means of a plug connector.

Box 14 of device ТКН-3Б protective glass heating system is intended for connection and control of the glass heating. It consists of the housing, accommodating switch 15, signal light 13 and a plug connector.

5.7.4. Operation of Temperature Regulator

To switch on the heaters of the group of vision devices connected to relay box KP-60, set switch B2 (Fig.126) to position ON (switch 3 in Fig.125), and switch B1 to one of the following positions:

UPPER (ВЕРХ) - upper prisms heating;
COMMON (ОБЩ) - upper and lower prisms heating;
LOWER (НИЗ) - lower prisms heating.

When switch B1 is set to position COMMON or LOWER, connected to the temperature regulator measuring bridge is the thermistor (the TOC temperature pickup) of the lower window (prism) of the main vision device ТНПО-170, and in position UPPER, the TOC temperature pickup of the device upper window.

The temperature regulator PTC measuring bridge is balanced with the resistance of temperature pickup TOC of the main device outlet window at +30°C temperature at the glass surface. At +30°C temperature between the bridge points the voltage is equal in value, triode ПТ-1 is cut off, the heaters are deenergized since electromagnetic relay P1 is deenergized.

[redacted]

At an ambient [illegible] is greater than at +30°C, which results in disturbing the balance of the arms and difference of potentials appears on the bridge arms. This will make triode ПТ-1 conductive, which in turn makes triodes ПТ-2 and ПТ-3 conductive and the voltage is applie from the amplifier to the winding of relay P1 of the amplifier. Relay P1 operates and throu closed contacts P1 (3-5) the mains "+" voltage is fed to the winding of box KP-60 contacto P1 and P3. Contactors P1 and P3 operate and voltage is fed via the contacts to the heating elements of the vision devices inlet and outlet windows.

As the glasses are heated, temperature pickup TOC is also heated and its resistance i reduced, thus bringing about variation of current flowing in the measuring bridge arms.

With the glass surface temperature of the main device reaching +30°C, the resistance pickup TOC drops so that equality is set up in the measuring bridge arms and the bridge is balanced - triodes ПТ-1, ПТ-2, and ПТ-3 are cut off, and the windings of amplifier relay P are deenergized. As a result, the mains "+" voltage is removed from the contactor windings and heating elements of devices ТНПО-170 - the heating elements are cut off.

As the devices cool down, the heating cycle is repeated until power supply is cut of after heating.

Operation of PTC temperature regulator in the circuits with box KP-55 and regulator PTC-27-3 is similar to the one described above.

5.8. AIR-LIQUID CLEANING SYSTEM OF DEVICES ТВНО-2, ТНПО-170 and ТКН-3Б

5.8.1. General

The system is used for cleaning the upper prism of driver's middle vision device, device ТВНО-2 and the protective glass of commander's device ТКН-3Б.

To clean devices ТНПО-170 mounted in the commander's hatch door, it is necessary to the latter and bring the respective device forward on the vehicle longitudinal axis.

5.8.2. System Design

The cleaning system consists of tank 32 (Fig.127), ejector 22, electropneumatic val nozzles 6 and 10, distributing cock 21, pipelines 16, 24, 25 and hoses 2, 17, 20 and 26.

For cleaning of the device, set distributing cock handle 23 to one of the extreme p tions depending on what device (driver's or commander's) must be cleaned and press butt CLEANING (ОЧИСТКА) on the central panel or button 37 on the separate devices cleaning p to the left of the commander.

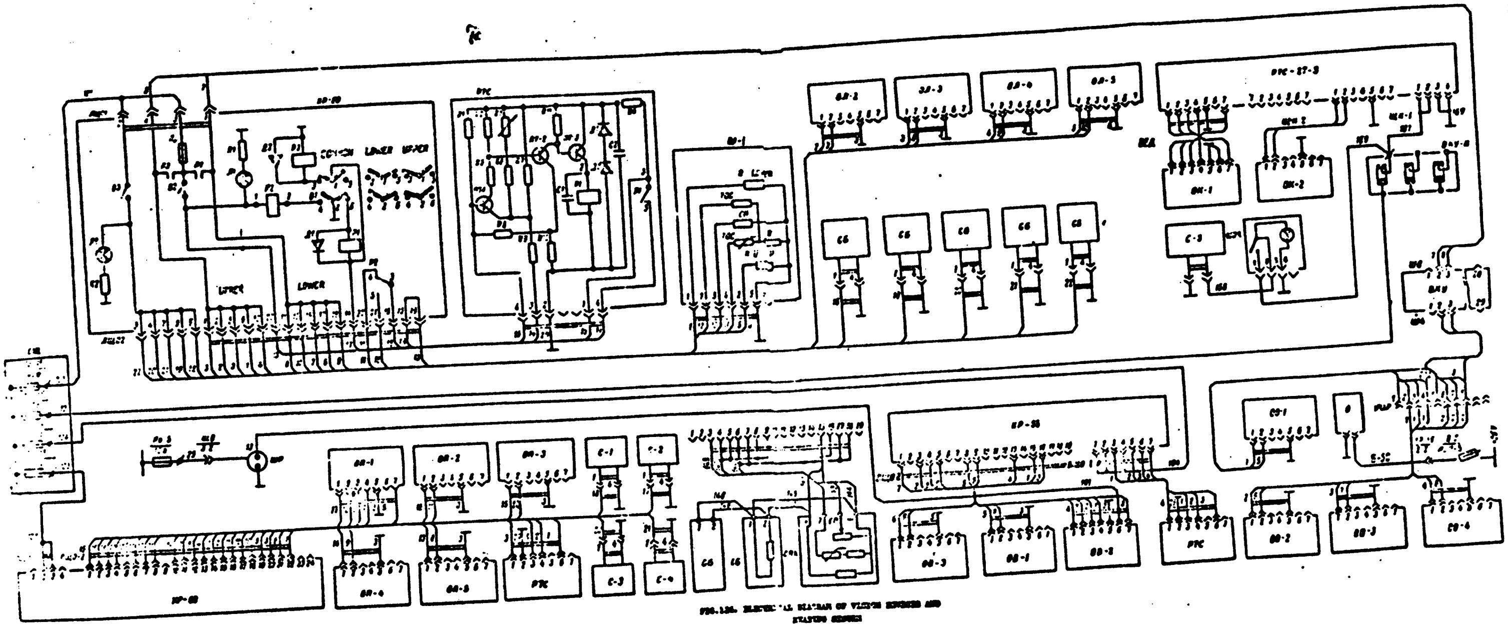
The welded tank (Fig.128) of 3.5-l capacity is installed in the hull bay to the lef the driver and is secured by three lugs 2 to the bosses. The filler neck closed with plu is provided in the cover of tank 3, and a drain hole closed with a plug is made in the t Pipe 5 to take the liquid in the system passes through the tank upper wall and reaches t tank bottom. Fitted on the pipe upper end is hose 26 (Fig.127), the other end of the ho connected with ejector 22 pipe.

The ejector is intended to create high-velocity flow of air with the purpose of fo of liquid emulsion for washing of the glasses. It consists of housing 8 (Fig.128), unio pipe 7 for connection of the hose running from the tank, nozzle 9 receiving bent pipe 1 connecting union 6 with the nozzle. Connected to union 6 is the air line running from t electropneumatic valve. Slot "a" for passage of liquid is provided between nozzle 9 and housing. When the electropneumatic valve operates, the air passing through nozzle 9 acc its motion creating rarefaction, which draws liquid from the tank into the ejector hou and is mixed with the air forming liquid emulsion, which is delivered to the distributi cock.

[redacted]

[redacted]

Sheet 6



BP-20
PTC
BP-1
BA-2
BA-3
BA-4
BA-5
PTC-27-3
BK-1
BK-2
C6
C-3
BKU
BP-35
CO-1
BA-1
C-1
C-2
C-4
BP-80

FIG.136. ELECTRICAL DIAGRAM OF [illegible] [illegible] AND [illegible] [illegible]

B3 - circuit breaker (AZP-5); PCP - turret collector ring box (PKJ-7TD-1); [illegible] - [illegible] collector ring box; [illegible] - [illegible]; EP-35 and [illegible] - heater [illegible]; heater of sight glass; [illegible] - heaters of vision devices [illegible] - operator's [illegible] driver's; [illegible] - commander's, [illegible] - troop compartment, [illegible] - panel [illegible]; Rp-9, Rp-15, Rp-16, Rp-17, Rp-19 - [illegible]

temperature regulators of glasses: C-1, C-2, C-3, C-4, C5 - troop compartment firing port glasses; C-5 - protective glass of [illegible]; [illegible] - [illegible] protective glass; [illegible] - power [illegible]; [illegible] - dividing plug connector; [illegible] - variable resistor; [illegible] protective glass heater [illegible]; C3 - variable [illegible]; [illegible] - plug connectors; [illegible] - switch; [illegible] - signal lamps; P1 and P2 and P3 - switches; [illegible] P2 - relays; [illegible] - drivers control panel; [illegible] - sockets; TSO - thermal resistor

[redacted]

[redacted]

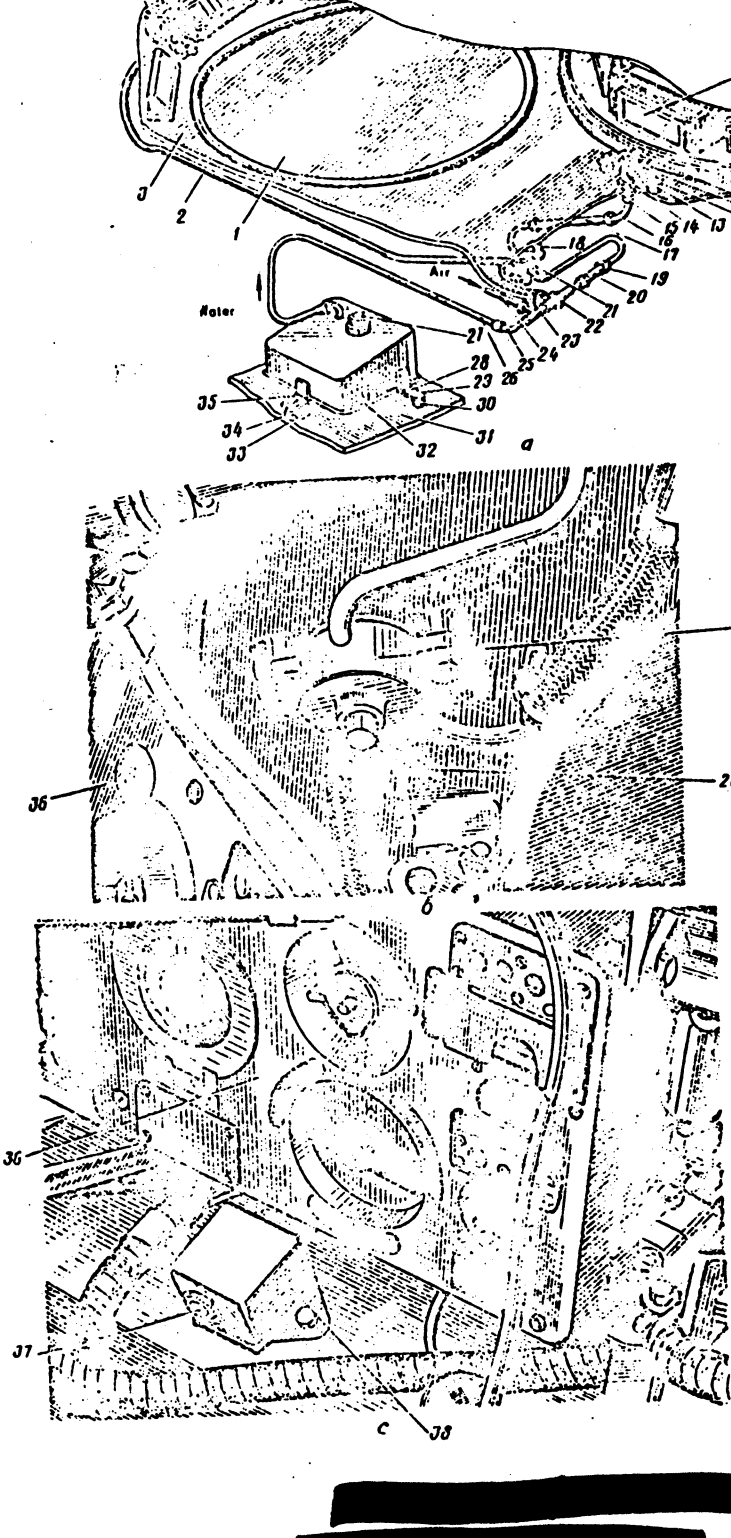


FIG.127. VISION DEVICES AIR-LIQUID CLEANING SYSTEM

a - system; b - cock; c - panel
1 - driver's hatch door; 2 - driver's vision device emulsion supply hose; 3 - hull roof; 4 - nozzle union; 5 - visor; 6 - driver's vision device cleaning nozzle; 7 - driver's middle device, 8 - device ТНП-3П protective glass; 9 - commander's hatch; 10 - commander's device cleaning nozzle; 11 - nozzle visor; 12 - visor attaching bolt; 13, 18, 30 - bosses; 14 - nut; 15 - union; 16 - commander's device emulsion supply pipeline; 17 - pipeline hose; 19 - hose attaching clamp; 20 - hose of cock-to-tank connecting pipeline; 21 - distributing cock; 22 - ejector; 23 - distributing cock handle; 24 - cylinder-to-ejector air pipeline, 25 - tank-to-ejector water supply pipeline; 26 - hose; 27 - tank plug, 28 - tank attaching bracket; 29 - tank attaching bolt; 31 - hull bow sloping plate on driver's left, 32 - tank for liquid, 33 - bracket; 34 - catch, 35 - bracket, 36 - radio station; 37 - button; 38 - panel

[redacted]

[redacted]

The two-position plug type [illegible] above the radio station. The cock is designed to direct the air-liquid flo driver's middle vision device or to the commander's device.

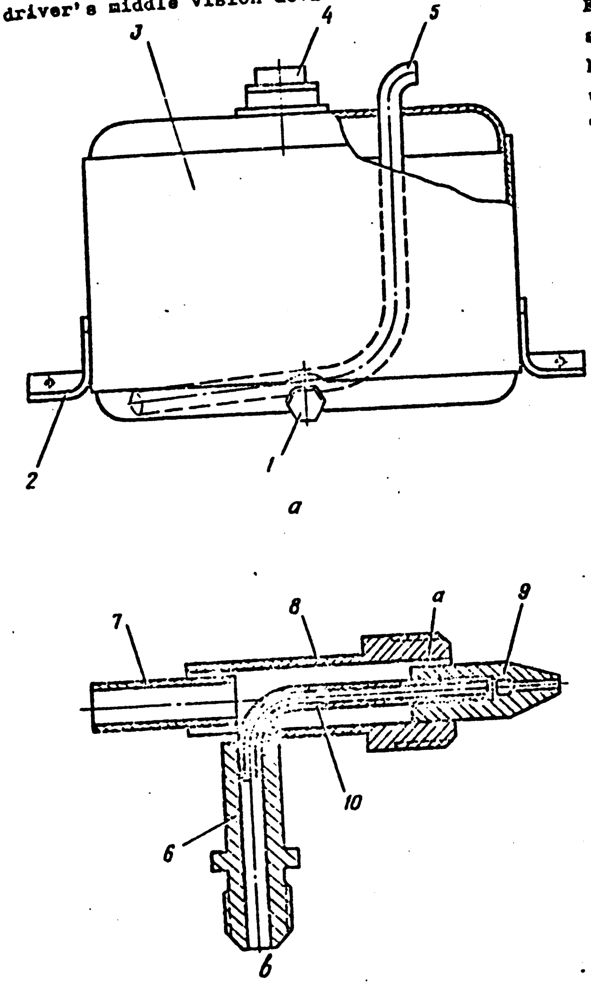


FIG.128. TANK AND EJECTOR

a - tank; b - ejector
1 - drain plug; 2 - attaching lugs; 3 - tank; 4 - filler neck plug; 5 - intake pipe; 6 - union; 7 - pipe; 8 - housing; 9 - nozzle; 10 - inner pipe; a - clearance (slot)

From distributing cock 21 (Fig.127) the air-liquid mixture passes through flexible hoses 2 and 17 to the pipes connected to unions 4 and 15 secured in the hull roof. The unions pass through the roof. Fastened to the unions from the outside are pipes with nozzles 6 and 10. Through the nozzles, the mixture gets on the outside surfaces of the vision devices glasses.

To clean the protective glass of device TKH-35 the distributing cock handle must be set in the rear position. In this case the driver's vision device cleaning system is cut off.

5.9. COURSE INDICATOR

5.9.1. General

The course indicator is intended for driving the vehicle along the preset course for a short time when visibility is absent (underwater driving) or under unfavourable conditions of orientation (lack of distinct reference points or their bad visibility).

Used as the course indicator is gyro direction indicator ГПК-59. The course indicator set incorporates the gyro direction indicator and converter ПАГ-1Ф.

The gyro direction indicator is installed in the driving compartment on a bracket located under the driver's central panel.

Converter ПАГ-1Ф is secured in the vehicle front part on the lower front plat

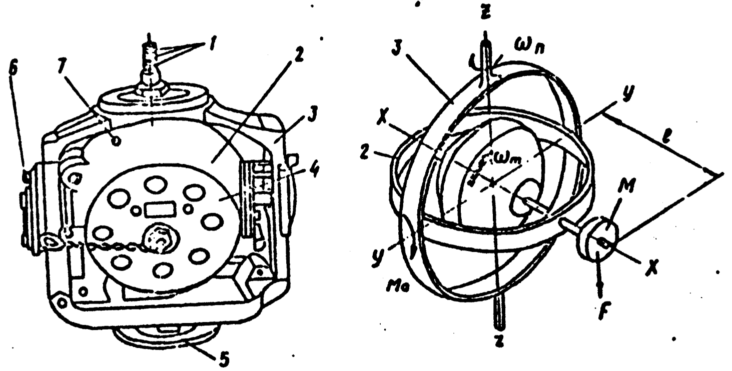
5.9.2. Principle of Operation of Gyro Direction Indicator

Operation of the course indicator is based on the property of the gyroscope spinning at a high speed to maintain the direction of its spinning axis set during the initial orientation.

Used in the gyro direction indicator is the free gyroscope, which may spin relative t main axis X-X (Fig.129) on the movable inner frame 2. The inner frame rotates freely with respect to outer frame 3 around Y-Y axis, and the outer frame, in its turn, rotates around axis Z-Z relative to the device housing in the bearings installed in the housing.

The system of two rotating frames with one of them carrying the gyroscope spinning ax makes the gyro gimbal suspension. The gyro gimbal suspension ensures three degrees of free of the gyroscope spinning.

[redacted]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3
4
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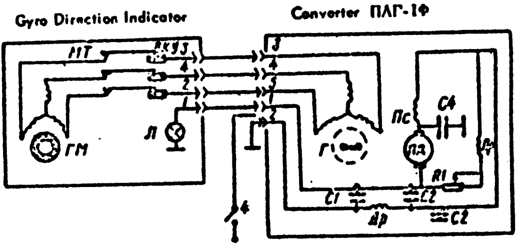
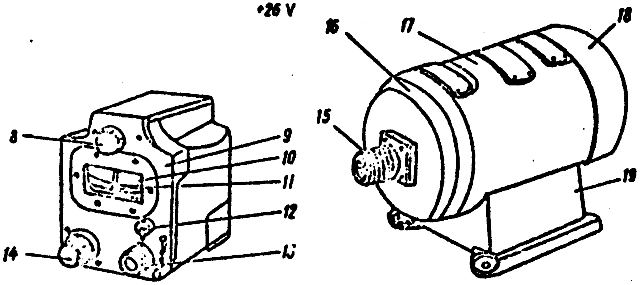
Device Electrical Diagram


Gyro Direction Indicator
Converter ПАГ-1Ф
ПТ
3
4
2
1
Л
ГМ
Пс
С4
Г
ПЛ
R1
С1
С2
Др
С2
4
+26 V


8
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19

FIG.129. GYRO DIRECTION INDICATOR ГПК-59 WITH CONVERTER ПАГ-1Ф

1 - rings of turret collector ring box; 2 - gyromotor inner frame; 3 - gyromotor outer frame; 4 - gyromotor; 5 - erection torque motor; 6 - current conductor; 7 - nozzle; 8 - scale illumination lamp holder; 9 - casing of gyro direction indicator; 10 - scale; 11 - index; 12 - plug; 13 - screwdriver; 14 - caging device knob; 15 - plug connector; 16 - cover; 17 - converter ПАГ-1Ф; 18 - cover; 19 - converter attaching bracket

[redacted]

The axis of direction when the vehicle turns and the index, statically indicates the angle of the vehicle turn by the scale secured to outer frame 3 of the gyro gimbal suspension.

5.9.3. Design of Gyro Direction Indicator ГПК-59

The gyro direction indicator consists of the gyromotor, gimbal suspension, erection torque motor, azimuth corrector, housing and cover.

The gyromotor is used in the gyro direction indicator as the gyroscope rotor. It is an asynchronous three-phase electric motor with a balanced heavy rotor.

The gyromotor rotor is actually a flywheel housing a package made of electrotechnical steel plates with cutouts filled with an aluminium alloy, forming short-circuit turns of the rotor winding.

The stator is arranged inside the rotor and includes three star-connected windings.

As the three-phase alternating current flows in the stator windings, rotating magnetic field appears, which induces current in the rotor turns, creating its magnetic field. Interaction of the magnetic fields makes the rotor rotate. The gyromotor is placed in the gyrochamber, serving simultaneously as the gyroscope inner frame 2.

The erection torque motor keeps the gyromotor main axis perpendicular relative to the plane of outer frame 3.

The perpendicular position is maintained by air-jet interframe corrector. The corrector air-jet stream is formed by means of two recesses diametrically arranged on the gyrochamber cylindrical surface. The recesses terminate in nozzles 7. The inner surface of the nozzles is located at a distance of 0.02-0.03 mm from the rotor surface.

The azimuth corrector is designed to keep the gyroscope main axis in the fixed position relative to the terrain reference points.

For this purpose it is necessary to apply to the gyroscope inner frame (relative to Y-Y axis) the external moment having the value and direction enough to make the gyroscope precess around its vertical axis in the direction of the earth rotation.

In the ГПК-59 gyro direction indicator this device is made as an adjusting screw, moving along the thread relative to the gyrochamber.

As the screw is turned in (out) the moment of gravity on the inner frame is varied, which causes precession of the outer frame with the respective speed, thereby compensating the influence of the Earth daily rotation and providing for the unchanged position of the gyroscope main axis relative to the reference points.

The current is fed to the gyromotor through the vertical axis of the gyro gimbal suspension with the aid of the slip ring assembly, arranged in the device upper part. It consists of the three movable slip rings, press-fitted on the vertical axis end and insulated from each other and the static contact springs, secured in the housing cover. Installed on the gyrochamber axle end are central contacts for current supply.

Current conductor 6 consists of the fixed contacts secured on the outer frame and movable contacts installed on the inner frame. The contacts touch each other in the points located on the frame geometrical axis of spinning. This arrangement allows to supply the current to the gyromotor with very small losses due to friction in the contacts.

The caging device is designed to cage the three axles of the gimbal suspension with the gyro inoperative as well as to set scale 10 to a preset angle. The gyro is caged by pressing knob 14, which results in appearance of red strip in the hole.

When the gyro is uncaged (knob 14 is pulled) the hole is closed with a black strip. Rotating knob 14, it is possible to set the scale to the required position.

[redacted]

[redacted]

Converter ПАГ-10 is designed to convert the vehicle mains d.c. voltage into a.c. three-phase voltage, 36 V, 400 Hz needed for supply of the gyro direction indicator.

It is an enclosed electrical machine which combines in one housing a d.c. compound excitation electric motor and an a.c. three-phase generator excited by a permanent magnet.

The electric motor armature and the generator rotor are arranged on one axle.

5.9.5. Operation of Gyro Direction Indicator

When switch B1 on the central panel is turned on, the mains voltage is supplied to the electric motor of converter ПАГ-10. The motor armature starts to rotate and makes rotor of generator Г rotate. The generator voltage is fed along the axis of outer frame 3 and inner frame 2 to the windings of gyromotor ГМ. The gyromotor accelerates to 20.000 rpm 5-6 min after turning on, following which the gyro may be uncaged.

The erection torque motor automatically operates during the gyro direction indicator operation. The erection torque motor principle of action is as follows.

During its rotation, the gyromotor rotor draws a layer of air, which is shaped into a stream in the recesses on the gyromotor chamber and is then cut off the rotor surface by the air-intake portions of the nozzles. The air stream leaving the nozzles at a pressure about 100 mm H_2O creates the jet force, directed as indicated in Fig.130.

If the gyroscope main axis is perpendicular to the outer frame plane, both nozzles are in this plane and jet forces P (Fig.130a) do not create any moment relative to the gimbal suspension vertical axis.

When perpendicularity of the gimbal suspension axes is disrupted (as the inner frame is tilted) forces P are displaced from the outer frame plane and create and external moment on the outer frame relative to vertical axis Y-Y , acting on arm 1 (Fig.130b).

Under the action of this moment the inner frame (gyrochamber) performs precession towards the side opposite to its tilt until the nozzles are again in the outer frame plane, restoring perpendicularity of the axes.

The air stream flowing from the nozzles cools down heated parts of the gyro direction indicator, equalizing their temperature.

5.9.6. How to Use Course Indicator

To operate the course indicator, proceed as follows:

- before switching on make sure that the gyro direction indicator is caged (knob 14 (Fig.129) is depressed);
- set switch ГПК on the central panel in position ON;
- wait for 5 min and set the scale to preset angle;
- uncage the gyrodirection indicator by unfolding the locking strip down and pulling caging device knob 14 until a click is heard.

To turn off the gyro direction indicator, cage it, raise the locking strip and turn switch ГПК off.

5.9.7. Care of Course Indicator

Care of the course indicator consists in:

- periodical cleaning of the gyro direction indicator and converter;
- checking the caging device, converter, gyromotor and illumination lamp for condition for which purpose switch on the device for 1-2 min;
- checking the gyro direction indicator, converter and wires for reliable fastening and checking the screwdriver and plug on the gyro direction indicator panel for presence.

[redacted]

Checking is performed during preventive maintenance No.2 on the move.

The drift must not exceed ±40 mils (two small scale division) for 30 min. If the drift exceeds the above value, perform balancing, for which purpose:

- cage the gyroscope and set the scale at 0;
- unscrew plug 12 on gyro direction indicator face panel;
- screw out screwdriver 13;
- insert the screwdriver in the hole for balancing and insert it into the slot of adjusting screw 2 (Fig.130);
- turn the screw to the side opposite to the scale drift. Turn the screw through approximately two-three divisions marked on the screwdriver handle to compensate for each division (20 mils) of the scale drift;
- take out the screwdriver, place it in position and screw up the plug.

After balancing check the drift, if the latter exceeds two scale divisions for 30 min repeat the balancing, following the same procedure.

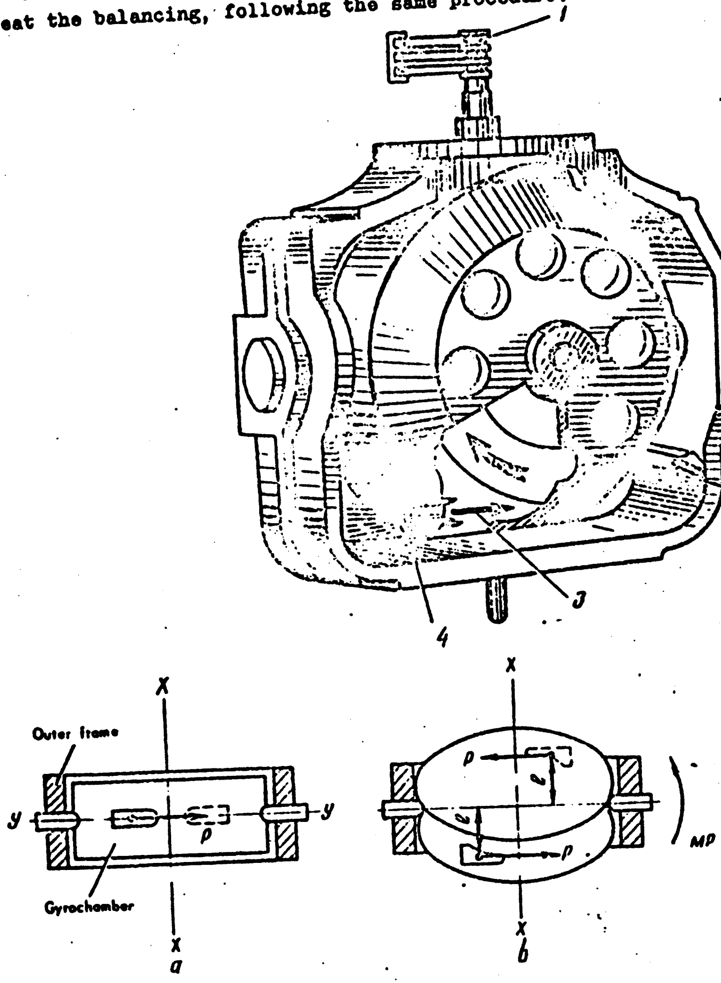

FIG.130. DIAGRAM SHOWING PRINCIPLE OF OPERATION OF AIR-JET AZIMUTH CORRECTION

1 - current conductor; 2 - latitude balance screw; 3 - jet force direction; 4 - nozzle; a - during perpendicular position of all gyro direction indicator axes; b - when gyro direction indicator main axis is turned relative to Y-Y axis

[redacted]

6. POWER PLANT

6.1. PURPOSE AND COMPONENTS

The power plant is the source of the vehicle energy, which sets it in motion.

It comprises engine УТД-20 and its systems: fuel feed, air supply, lubrication, cooling, preheating and starting.

6.2. ENGINE

6.2.1. General

The УТД-20 engine is a six-cylinder, V-type (the vee angle is 120°), four-stroke, hig speed, airless-injection engine with high-temperature liquid cooling.

The engine is mounted in the engine compartment, being a component of the power plant, which includes also the gearbox, engine clutch and planetary steering gears.

The power plant is secured on two hoops and on a flexible support.

The hoops are arranged in the vehicle front part. Bases 12 (Fig. 8) of the hoops are welded to the lower front armour plate of the hull. The cylindrical housings of the steerir gears rest on the hoops and are secured in them with the use of bolts by the upper caps.

The third rear support is flexible (Fig. 131) and consists of a bracket, secured with bolts 4 to the vehicle bottom in the middle part of the engine compartment and flexible ring 1. Ring 1 is installed on cylindrical neck 18 (Fig. 132) of the engine cylinder block-and-crankcase unit.

The engine crankshaft rotation is right-hand (clockwise) if viewed from the compressor power takeoff side.

The tunnel type engine cylinder block-and-crankcase unit consists of two banks with three cylinders in each bank. The cylinders of each bank have common cylinder heads.

General view of the engine is presented in Figs 132 and 133, and its sectional views, in Figs 134 and 135.

6.2.2. Engine Operating Cycle

The complete engine operating cycle is performed during four strokes of the piston – during two crankshaft revolutions. The strokes of the engine operating cycle are: admission, compression, expansion and exhaust.

The admission stroke occurs during piston motion from the top dead center (TDC) to the bottom dead center (BDC). Rarefaction is created in the cylinder during this stroke and the atmospheric air is sucked into the cylinder through open intake valves. For better filling of the cylinder with air the intake valves open 20° before the piston reaches TDC and get closed when the piston is 48° after BDC. Thus, the admission stroke occupies 248° of the crankshaft travel.

The compression stroke starts from the moment of closing of the intake and exhaust valves during the piston movement from BDC to TDC.

[redacted]

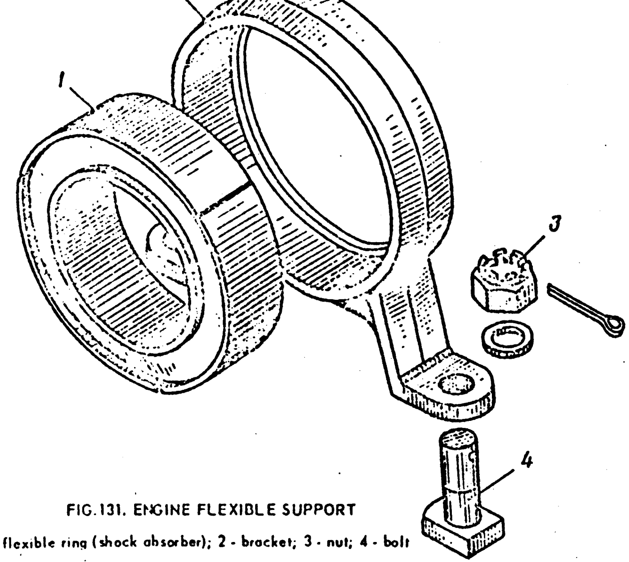

FIG. 131. ENGINE FLEXIBLE SUPPORT

1 - split flexible ring (shock absorber); 2 - bracket; 3 - nut; 4 - bolt

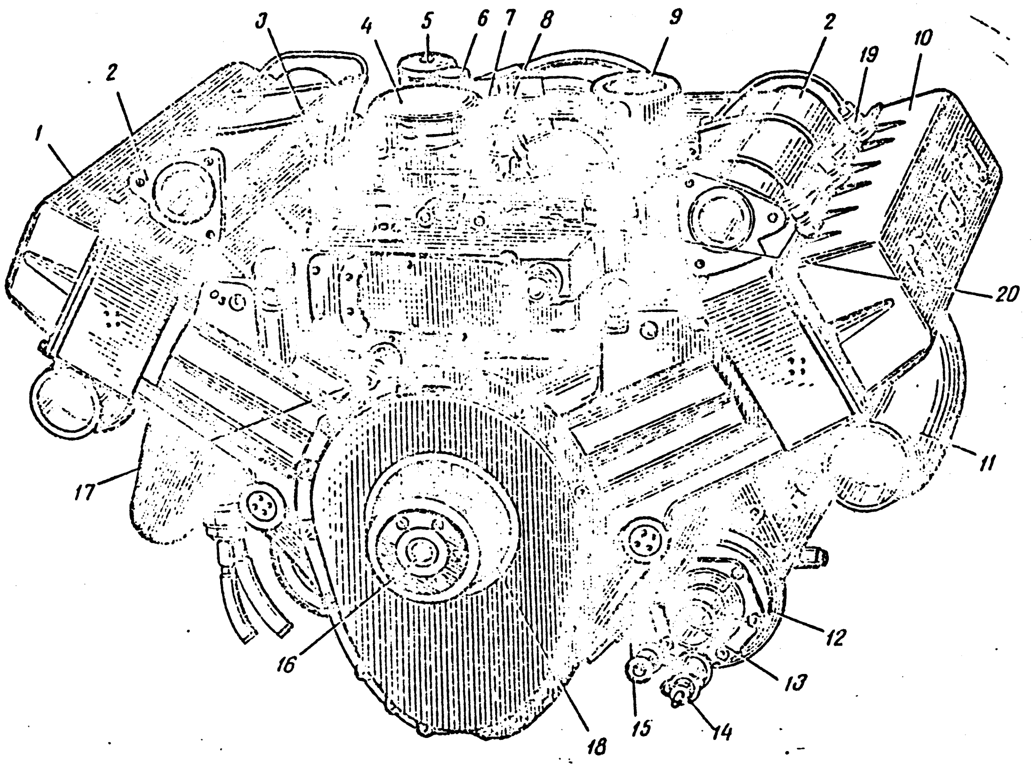

FIG. 132. ENGINE GENERAL VIEW (FRONT VIEW)

1 - cylinder head; 2 - exhaust manifold; 2 - fuel injection pump control lever; 4 - centrifugal oil filter; 5 - breather; 6 - coarse oil filter; 7 - fuel injection pump; 8 - fuel feed pump; 9 - fuel filter; 10 - cylinder head cover; 11 - intake manifold, 12 - water pump; 13 - coolant supply branch pipe; 14 - drain cock; 15 - coolant outlet pipe union; 16 - power take off shaft; 17 - union for supply of oil from oil priming pump; 18 crankcase neck; 19 - clamping nut; 20 - plug with governor dipstick

[redacted]

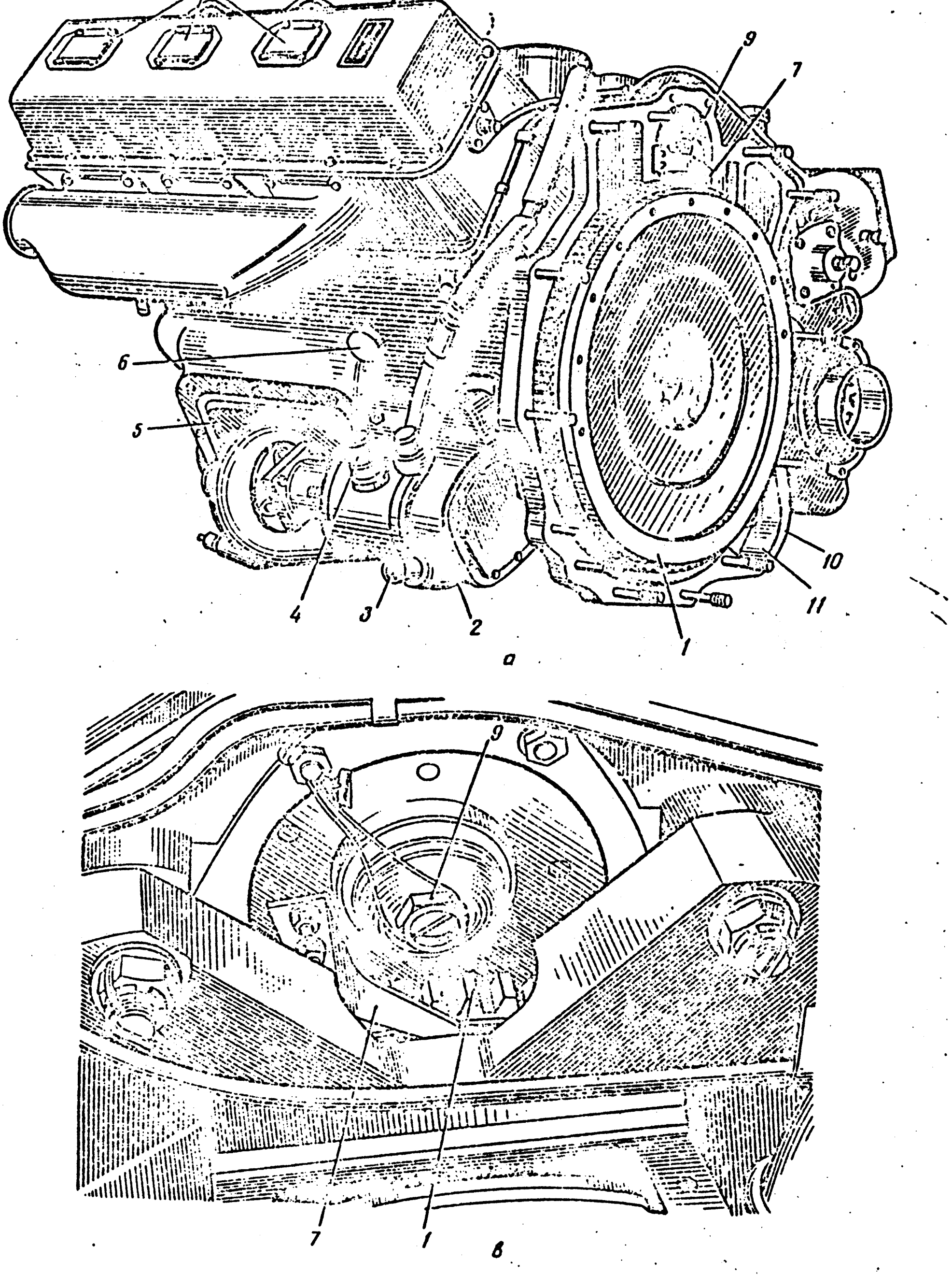

FIG. 133. ENGINE GENERAL VIEW (RIGHT SIDE)

a - engine; b - index

1 - crankshaft flywheel; 2 - oil pump; 3 - union for delivery of oil from oil tank; 4 - pump-to-oil cooler oil supply union; 5 - cover; 6 - technological plug; 7 - index for adjustment of fuel feed advance angle; 8 - covers; 9 - cover of fuel injection advance angle setting coupling; 10 - starter; 11 - starter gear

[redacted]

[redacted]

Fresh air admitted into the cylinder is compressed

lume above the piston. Towards the end of the stroke the air is compressed to a pressure o 36-39 kgf/cm^2. The air temperature during the compression reaches 550-600°C.

When the piston is [redacted] before TDC, the atomized diesel fuel is injected int the space above the piston.

The stroke is over when the piston reaches TDC.

Expansion stroke begins after the compression stroke. Due to high temperature of the compressed air the fuel injected in the combustion chamber is ignited.

When the piston passes TDC, the gas pressure sharply grows to 80-90 kgf/cm^2, and the temperature - to 1800-1900°C.

Under gas pressure the piston moves to BDC, acting through the connecting rod on the crankshaft pin and thus, performing the expansion (working) stroke.

Due to expansion the gas pressure is reduced to 2.5-3 kgf/cm^2, and the temperature - to 700-800°C.

Thus, the thermal energy created during fuel combustion is converted into mechanical energy of the piston motion.

The exhaust stroke begins from the moment of opening of the exhaust valves, i.e. wher the piston is in the position of 48° before BDC in the expansion stroke.

The products of combustion are expelled from the cylinder:

- during the piston motion to BDC in the expansion stroke due to difference of pressure in the cylinder and the ambient air pressure (pressure in the cylinder at the moment opening of the exhaust valves is 2.5 - 3 times higher than the ambient pressure);
- due to expulsion of the exhaust gases by the piston, moving towards TDC in the exh stroke;
- due to inertia of the gas flow and replacement of gases with fresh air when the in valves get opened in the admission stroke with the piston moving from TDC to BDC.

The exhaust period occupies 248° of the crankshaft travel (in the expansion stroke - 48°, compulsory exhaust - 180°, and in admission stroke - 20°).

From the beginning of admission (20° before TDC) up to the end of exhaust (20° after TDC), i.e. during 40° of the crankshaft travel, the intake and exhaust valves are open simultaneously. In this range, which is named overlapping of valves, the cylinder is blow off, which provides for better cleaning of the cylinder of the exhaust gases and better f ling with fresh air charge.

The moments of opening of the intake and exhaust valves are called the valve timing, and their graphical representation is called the valve timing diagram (Fig. 136).

The angle of the beginning of fuel delivery by the fuel injection pump is set at 24 - 27° before TDC in the compression stroke.

The power and economy characteristic (external characteristic) of the engine is presented in Fig. 137.

Shown in the figure is variation of power N, torque M_t and specific fuel consumptior depending on engine crankshaft speed n at maximum fuel feed (the fuel feed pedal is depr sed as far as it will go). This graph is called the engine external characteristic.

6.2.3. Engine Design

Crank Gear

The crank gear is designed to convert the pistons reciprocating motion into rotur tion of the crankshaft.

The crank gear consists of the cylinder block-and-crankcase unit, crankshaft, flywh connecting rods, pistons and power takeoff shaft.

The cylinder block-and-crankcase unit is designed for assembly of all parts, units serves as the engine power frame. The cylinder block-and-crankcase unit is divided by ri

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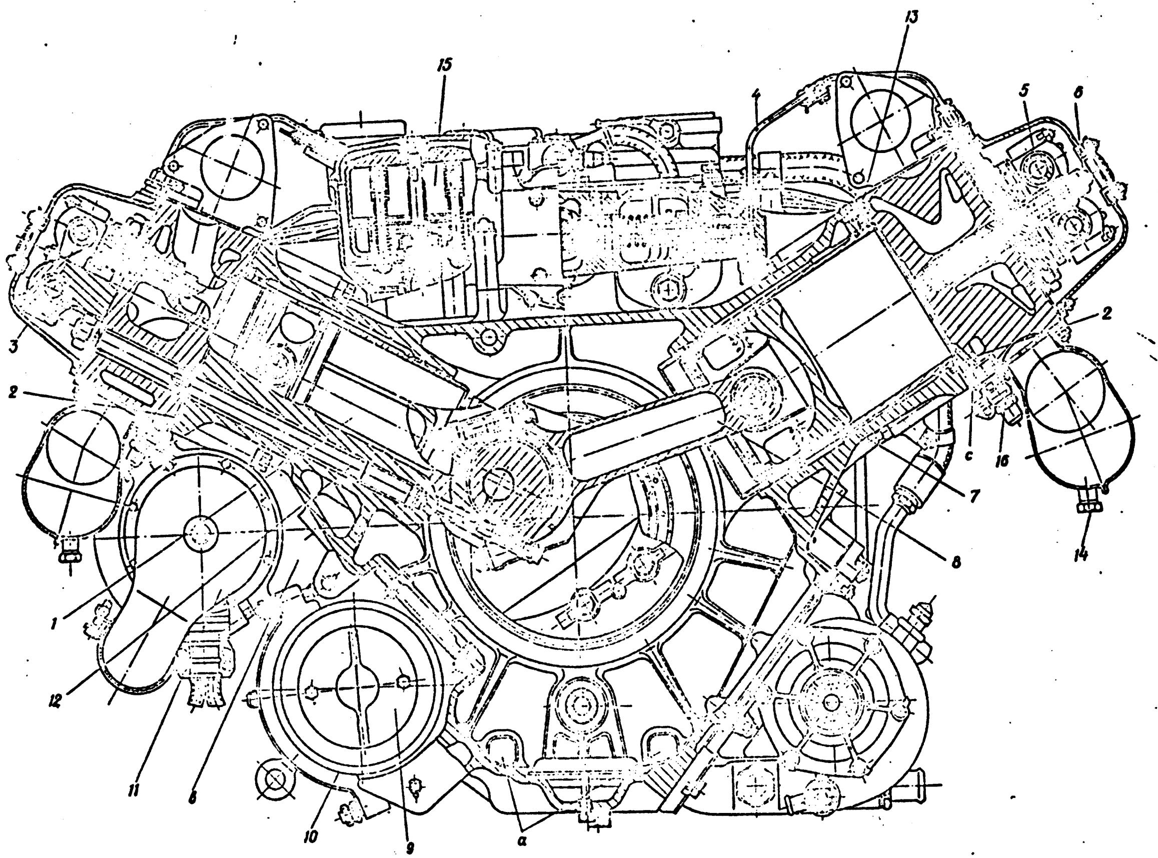

FIG.135. ENGINE (CROSS SECTION)

1 - forked connecting rod; 2 - copper gasket; 3 - intake camshaft; 4 - H.P. pipeline; 5 - exhaust camshaft; 6 - injector; 7 - piston; 8 - articulated connecting rod; 9 - starter; 10 - half-hoop; 11 - generator; 12 - anchor stud; 13 - brass pipe; 14 - drain plug; 15 - centrifugal oil filter; 16 - starting valve; a - ducts for heating crankcase with coolant; b - crankcase lug; c - duct for passage of compressed air

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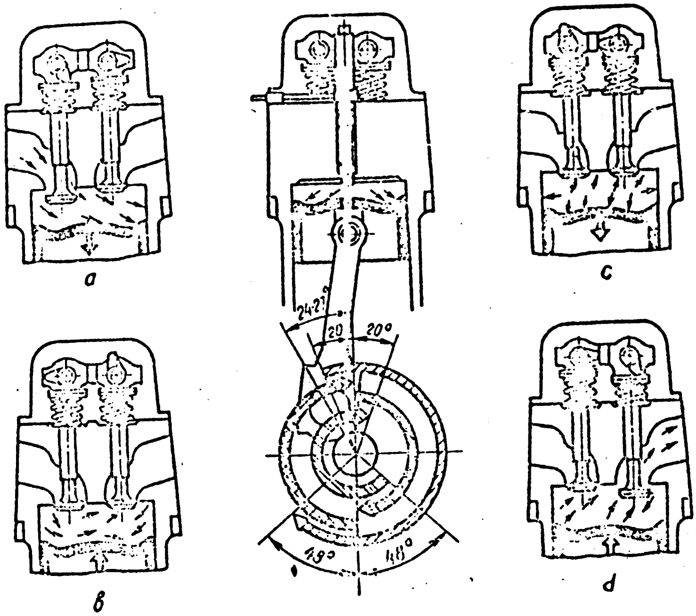

FIG.136. VALVE TIMING DIAGRAM

a - admission stroke; b - compression stroke; c - expansion stroke; d - exhaust stroke

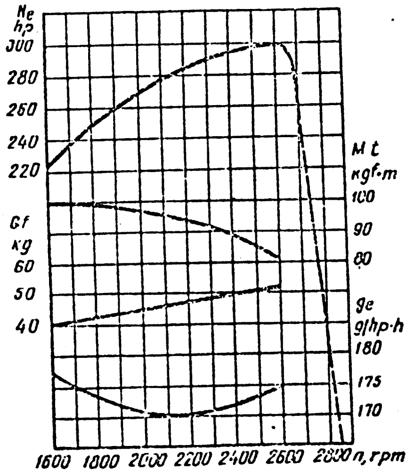

FIG.137. ENGINE EXTERNAL CHARACTERISTIC

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transverse partitions 18 (Fig 134) tion of the accessory drive. Pressed in the central borings of the partitions are races 21. The races are secured against turning with lockpins 19. Crankshaft 4 is mounted on roller main bearings 7 and 8 in the tunnel formed by the borings in the partitions.

Made in the lower part of the partitions parallel to the main bearings axis are the borings accommodating balancing mechanism shaft 1. Screwed into the lower part of the second section is plug 14 (Fig. 135) for draining of oil from the crankcase. The space above the plug is closed with gauze 26 (Fig. 134).

Made on the rear end of the cylinder block-and-crankcase unit is shaped flange 24 with the studs for attachment of the power transmission housing that forms one assembly together with the cylinder block-and-crankcase unit. From the left side of the cylinder block-and-crankcase unit there is a bed for installation of starter 9 (Fig. 135), which is secured to it by half-hoops 10. Generator 11 is secured above the starter bed on lug "b".

Made from above along the axis of the cylinder block-and-crankcase unit vee is the lug with the boring inside, accommodating the fuel injection advance angle setting coupling. Centrifugal oil filter 15 is secured in the vee of the cylinder block-and-crankcase unit by means of four studs.

Each cylinder bank has three borings accommodating cylinder liners 10 (Fig. 134). Each boring has a recess for cylinder liner shoulder 13, two seating collars for centering the liner and a space forming in conjunction with the liner wall an annular duct for passage of the coolant.

The cylinder liners are made of high alloy steel. To increase hardness and wear resistance, the inner surface of the liners is nitrated.

For sealing of the cooling space provided on the liner lower seating collar are three grooves for rectangular rubber sealing rings 9; the upper seating collar has one groove for round rubber sealing ring. Installed at the top of the cylinder liner is copper gasket 2 (Fig. 135) packing the gas joint.

The coolant passes from the cooling spaces of the liners into cooling spaces of the cylinder heads through the drillings in the cylinder block upper part and in the cylinder heads. The joint of the drillings is packed by means of brass pipes 13 with rubber rings fitted thereon.

Screwed into the cylinder block-and-crankcase unit partitions are eight anchor studs 12 (on each side) for securing the cylinder heads.

To prevent ingress of coolant and oil in the anchor stud wells, fitted on the studs are rubber sealing rings.

The head is locked on the cylinder block by the three locating pins, press-fitted in the cylinder block-and-crankcase unit.

Breather 5 (Fig. 132) is mounted for communication of the cylinder block-and-crankcase unit inside space with the atmosphere. Cylindrical breather body 1 (Fig. 138) is filled with wire filtering packing (tangled wire) 2 and is closed with cover 3.

Crankshaft 4 (Fig. 134) is stamped of alloy steel and has three crankpins 16 (Fig. 139) and four main journals 17 with elliptical webs 18 arranged in-between.

Secured by bolts 15 to the first and second webs are counterweights 19. Secured to the crankshaft from one end is flywheel 23 (Fig. 134); from the other side the crankshaft carries press-fitted crankshaft end 5.

The crankshaft main journals rotate in roller bearings 7 and 8. The first main journal carries thrust roller bearing 1 (Fig. 139) locked against axial displacement by flange 2. The bearing outer race rests on sleeve 3, which is press-fitted with interference into the boring of the cylinder block-and-crankcase unit. The outer race is locked with split locking ring 4. The remaining three main journals are the races for roller bearings 20 installed in steel bushings 22 press-fitted in the borings of the cylinder block-and-crankcase unit. The outer races of the bearings are fixed by locking rings 21.

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the accessory drive side is accessory drive gear 7.

The crankshaft is packed with textolite split rings 8 pressed by the springs.

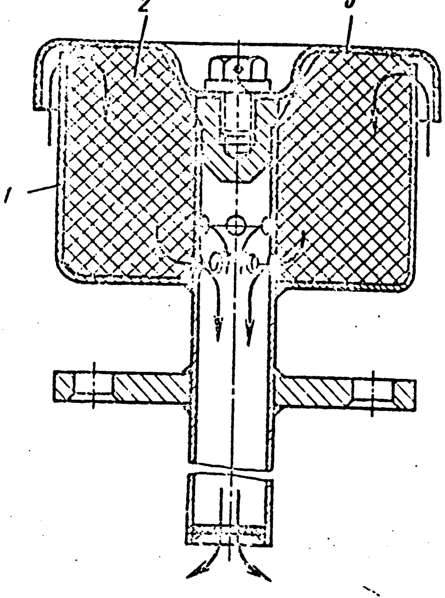

FIG.138. BREATHER
1 - body; 2 - filtering packing; 3 - cover

Spaces provided in the crankshaft crankpins are interconnected by slant drillings. On the ends the spaces are closed with stoppers 5.

Lubricant is supplied into the crankshaft through main oil channel drilled in cylinder block-and-crankcase unit, duct "c" in first bearing sleeve 3, through the space of end piece 23 and the drillings in it in the space of crankpin 16. Through the radial drillings in the crankpins oil is fed to the friction surfaces of the connecting rod bearing shells.

Flywheel 23 (Fig. 134) is intended to improve uniformity of the engine operation. It is secured to the crankshaft by bolts 9 (Fig. 139) and pins 10 in the definite position. The flywheel is provided with a gear rim for engagement of the starter gear. The flywheel rim is graduated in degrees, each division corresponding to one degree of the crankshaft turn. The graduation is used during checking of the valve timing and fuel injection angles.

Power takeoff shaft 24 transmits power from the engine to the reduction gear driving the compressor, compressor fan and water drainage pump (Fig. 311). The shaft is fitted in the splines of end piece 23 (Fig. 139) and is supported by ball bearing 25 arranged in spacer 26. Machined in the cavity of power takeoff shaft 1 (Fig. 140) are the splines receiving the external splines of the belt drive pulley shaft. Spacer 26 (Fig. 139) together with flange 27 is bolted to sleeve 3. The pulley shaft body is attached to flange 27 by six bolts.

Shaft 4 (Fig. 310) is supported by two ball bearings 8 installed in case 6 and packed with cups 5 and 9.

The balancing mechanism serves to balance the inertia forces appearing during the engine operation. These forces are balanced by two counterweights secured on the webs of the first crankpin, local removal of metal on the flywheel rim and a special balancing mechanism.

The balancing mechanism consists of shaft 1 (Fig. 134) with counterweights 2 and 25 at the ends. Counterweight 25 is made as a gear meshed with crankshaft gear 20.

Shaft 1 is supported by three antifriction bearings, installed in the cylinder block-and-crankcase unit lower part; the shaft rotates at the same speed as the crankshaft, but in the reverse direction.

The crank gear serves to convert the reciprocating motion of pistons into the rotary motion of the crankshaft. It consists of three twin connecting rods, having I-shaped cross section and made of high alloy steel. Each pair of the connecting rods consists of forked connecting rod 1 (Fig. 141) and articulated connecting rod 2. The forked connecting rod big end is mounted on the crankpin, and the articulated connecting rod big end enters its slot and holds the cylindrical surfaces of spacer 8 and forked connecting rod cap 6. The small ends of the forked connecting rods are coupled with the pistons of the left-hand cylinder bank and those of the articulated connecting rods, with the right-hand cylinder bank pistons. The piston stroke in both banks is the same.

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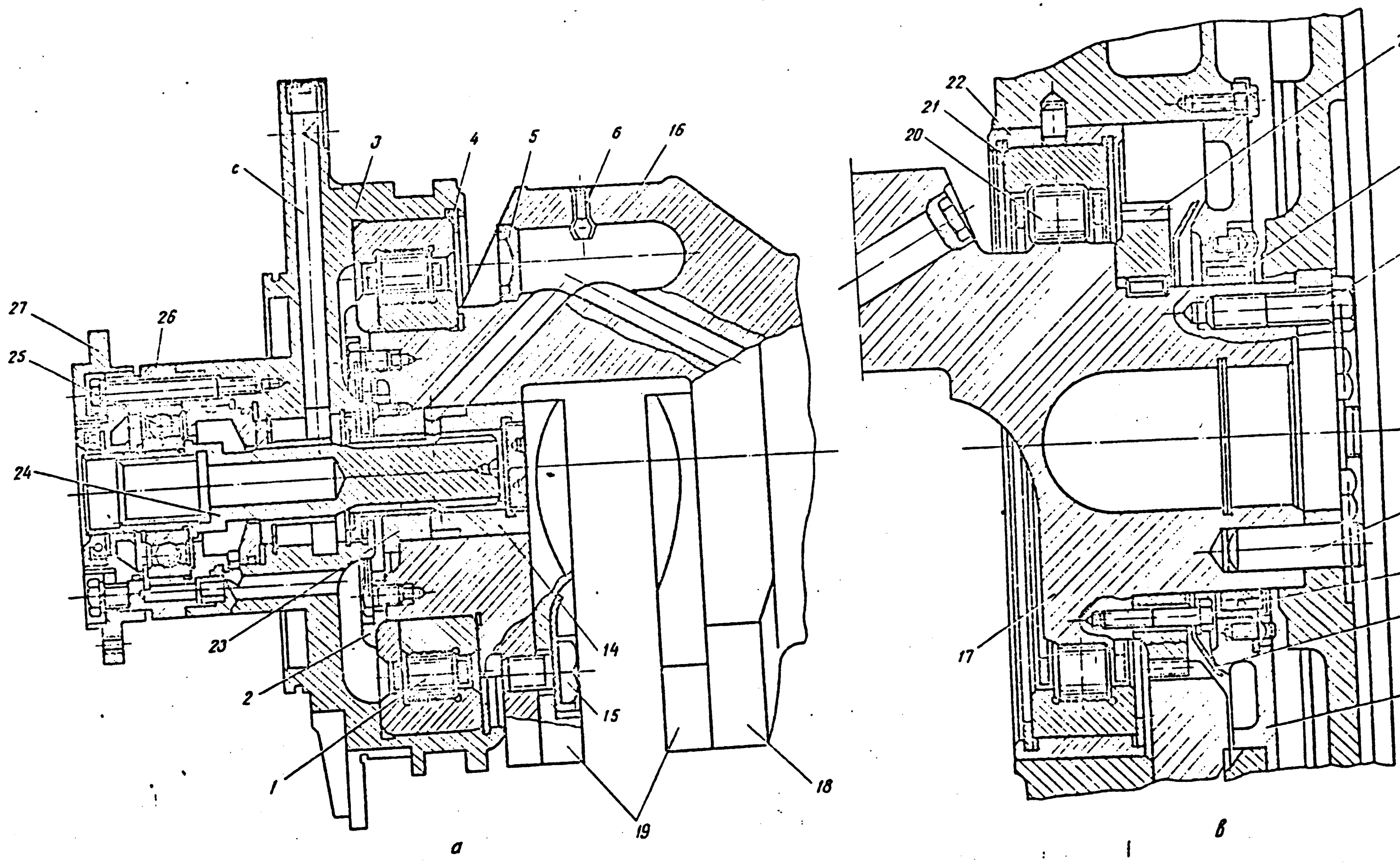

FIG.139. ENGINE CRANKSHAFT

a - section along first main journal; b - section along fourth main journal

1 - thrust roller bearing; 2 - thrust flange; 3 - first bearing sleeve; 4 - locking ring; 5 - stopper; 6 - pipe; 7 - accessory drive gear; 8 - crankshaft packing; 9 - flywheel attaching bolt; 10 - lockpin; 11 - oil deflector; 12 - rear cover; 13 - gear attaching bolt; 14 - crankshaft end; 15 - couterweight attaching bolt; 16 - crankpin; 17 - main journal; 18 - web; 19 - counterweights; 20 - roller bearings; 21 - locking ring; 22 - steel bushing; 23 - end piece; 24 - power takeoff shaft; 25 - ball bearing; 26 - spacer; 27 - flange; c - oil supply duct

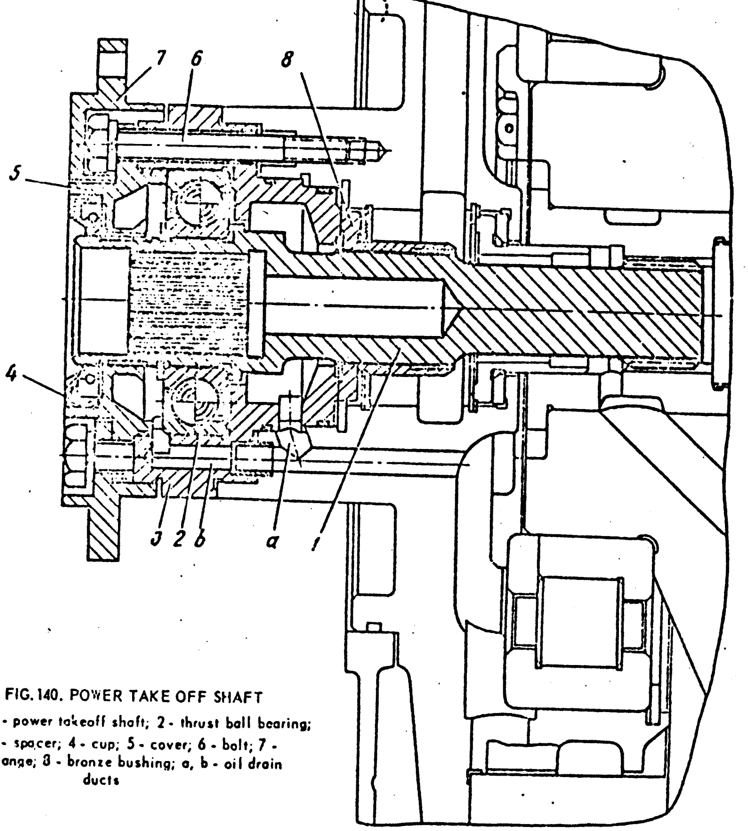

FIG. 140. POWER TAKE OFF SHAFT

1 - power takeoff shaft; 2 - thrust ball bearing; 3 - spacer; 4 - cup; 5 - cover; 6 - bolt; 7 - flange; 8 - bronze bushing; a, b - oil drain ducts

The forked connecting rod big ends are secured on the crankpins by means of bolts 16 which couple caps 6, bearing shells 7 and spacer 8 with stem 9 with the aid of nuts 20. The nuts are locked with cotter pins 19.

The articulated connecting rod big ends are coupled by bolts 13 with nuts 20 that are locked with cotter pins.

The joint surfaces of the big ends of connecting rods are splined to prevent displacement of the caps.

The thin-wall steel bearing shells are coated with a thin layer of lead bronze and lead-plated on the inside. Their outside surfaces are copper-plated. The shells are held against turning by lockpins 5 and 18.

The articulated connecting rod bearing shells are lubricated through holes in crankpins and drillings in shells 7, lower cap 6 and spacer 8.

Press-fitted in the connecting rod small ends are bronze bushes 10, serving as bearings for piston pin 11. The piston pin is lubricated by splashing of oil through six holes provided in the connecting rod small end. Pressed into one of these holes is brass pipe 4 retaining the bush from displacement.

The piston assembly consists of the piston, piston rings, piston pin and stoppers.

The piston takes up the pressure forces appearing due to combustion of fuel in the cylinder and imparts them to the connecting rod through the piston pin.

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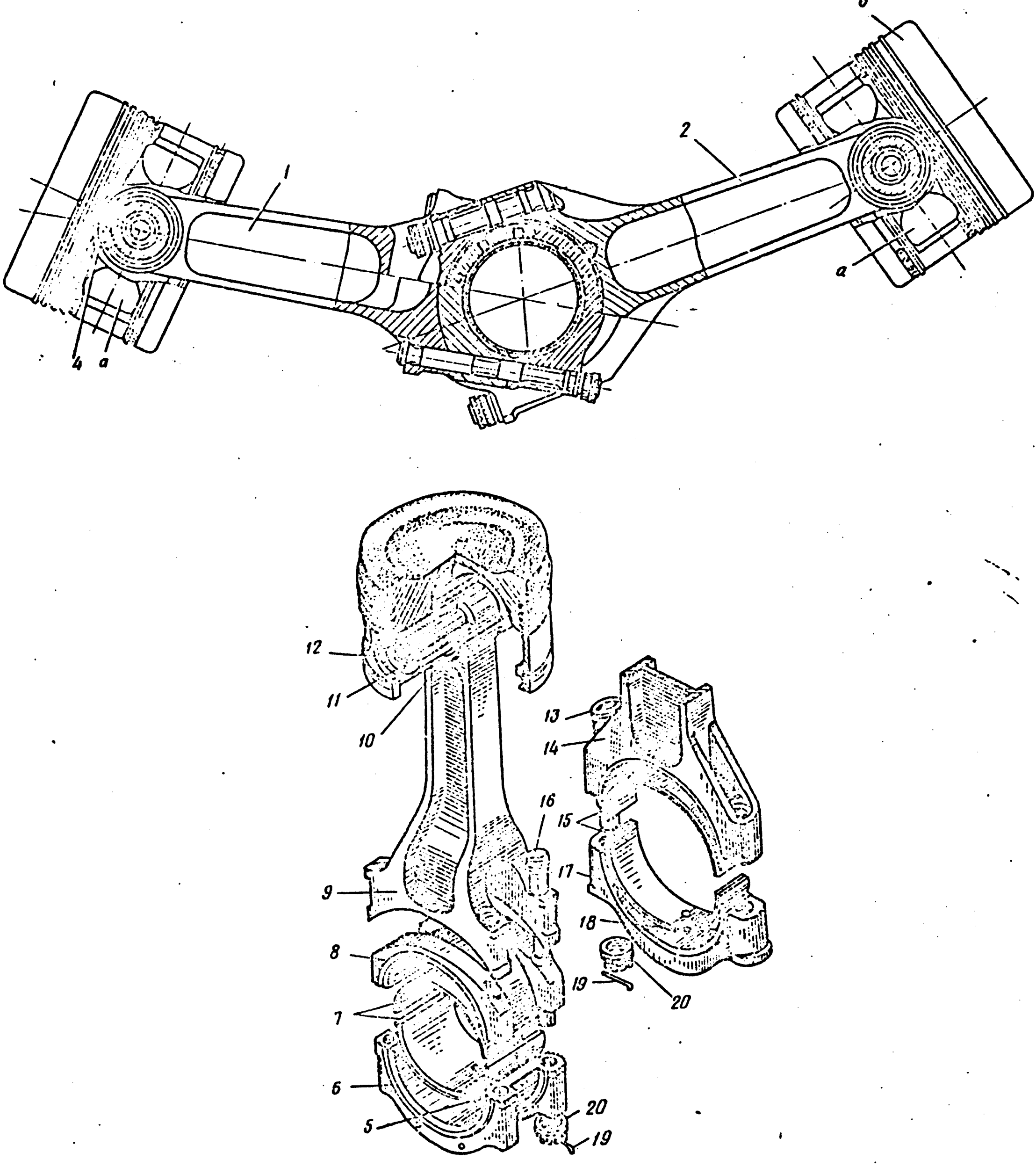

FIG.141. CONNECTING RODS AND PISTONS

1 - forked connecting rod; 2 - articulated connecting rod; 3 - piston; 4 - pipe; 5 - lockpin; 6 - forked connecting rod cap; 7 - forked connecting rod bearing shells; 8 - spacer; 9 - forked connecting rod stem; 10 - connecting rod small end bush; 11 - piston pin; 12 - stopper; 13 - bolt; 14 - articulated connecting rod stem; 15 - articulated connecting rod bearing shell; 16 - bolt; 17 - articulated connecting rod cap; 18 - lockpin; 19 - cotter pin; 20 - nut; a - recesses

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The piston (Fig. 142) is stamped of aluminium alloy.

The piston head is of a special shape providing for better formation of fuel-air mixture and combustion of fuel injected into the combustion chamber.

Provided on the piston skirt inner side are two bosses "a" with piston pin 11 (Fig.141) fitted into the borings of the bosses. Drilled in the bosses lower part are two holes from each side, through which the oil splashed in the crankcase passes for lubrication of the piston pin.

Turned on the piston generatrix are five grooves; four of them are located above the piston pin hole and one below. The fourth and fifth grooves have chamfers with oil drain holes "b" (Fig. 142). Fitted in the piston grooves are the piston rings.

Two upper rings 1 are compression, steel, trapezoidal in shape. They are coated with porous chrome. The trapezoidal shape of the ring assists in removal of the carbon deposit formed between the surfaces of the ring and groove.

The third and fourth rings 2 are combination ones, that is, alongside with sealing against penetration of gases they serve for removal of excess oil from the mirror surface of the cylinder liners. The combination rings have tapered cross section, with an angle of taper along the generatrix equalling 2°; they are manufactured of special cast iron. The rings are plated with a thin layer of hard chrome.

The fifth ring 3 is an oil ring, with an angle of taper along the generatrix equalling 6°; it is also manufactured of special cast iron.

The piston pin is of a floating type, steel, case-hardened on the outside and hollow. The piston pin is fitted into the bosses with interference. Pressed from both sides into the pin are bronze stoppers 12 (Fig. 141) retaining it from axial displacement; they protect the cylinder mirror surface from scoring by the piston pin ends.

The cylinder head (Fig. 143) of aluminium alloy is common for three cylinders. Machined on the cylinder head lower surface are three recesses, accommodating the liner shoulders "a" protruding beyond the cylinder block-and-crankcase unit surface. The cylinder head is secured to the cylinder bank by eight anchor studs and twelve coupling studs 11 and is positioned by means of three locating pins.

The joint between the cylinder head surface and shoulders of the liners is sealed by copper rings 2.

Machined from below in the cylinder head are three combustion chambers, each having four holes connecting the chamber with the intake and exhaust ducts. Pressed in the borings of these holes are steel valve seats 1 with tapered surfaces, to which the valve chamfered surfaces are tightly fitted. Drilled in the upper parts of the cylinder heads are holes with pressed-in bronze guide bushings 5. The valve stems move in these bushings.

Bored along the combustion chamber axis is a hole for installation of the injector.

The intake and exhaust ducts come out to the side surfaces of the head, to which intake manifold 9 and exhaust manifold 3 are attached. Studs are turned into the cylinder head for fastening the manifolds.

Screwed in below the intake port are threaded bushings accommodating air starting valves 10.

Mounted on the cylinder head upper surface are four camshaft bearings, one of them (the first on the accessory drive side) is a thrust bearing.

From above the cylinder head is closed with aluminium alloy cover 6. The cover flange has holes for studs attaching it to the cylinder head. The cylinder head-to-cover joint is sealed by a paronite gasket. Three access holes in the cylinder head cover closed by stamped covers 7 allow injectors to be installed or removed without removing the cylinder head cover.

The coolant is supplied into the cylinder head from below from the cylinder block-and-crankcase unit jacket space via the by-pass pipes into the holes made on the lower surface of the cylinder head.

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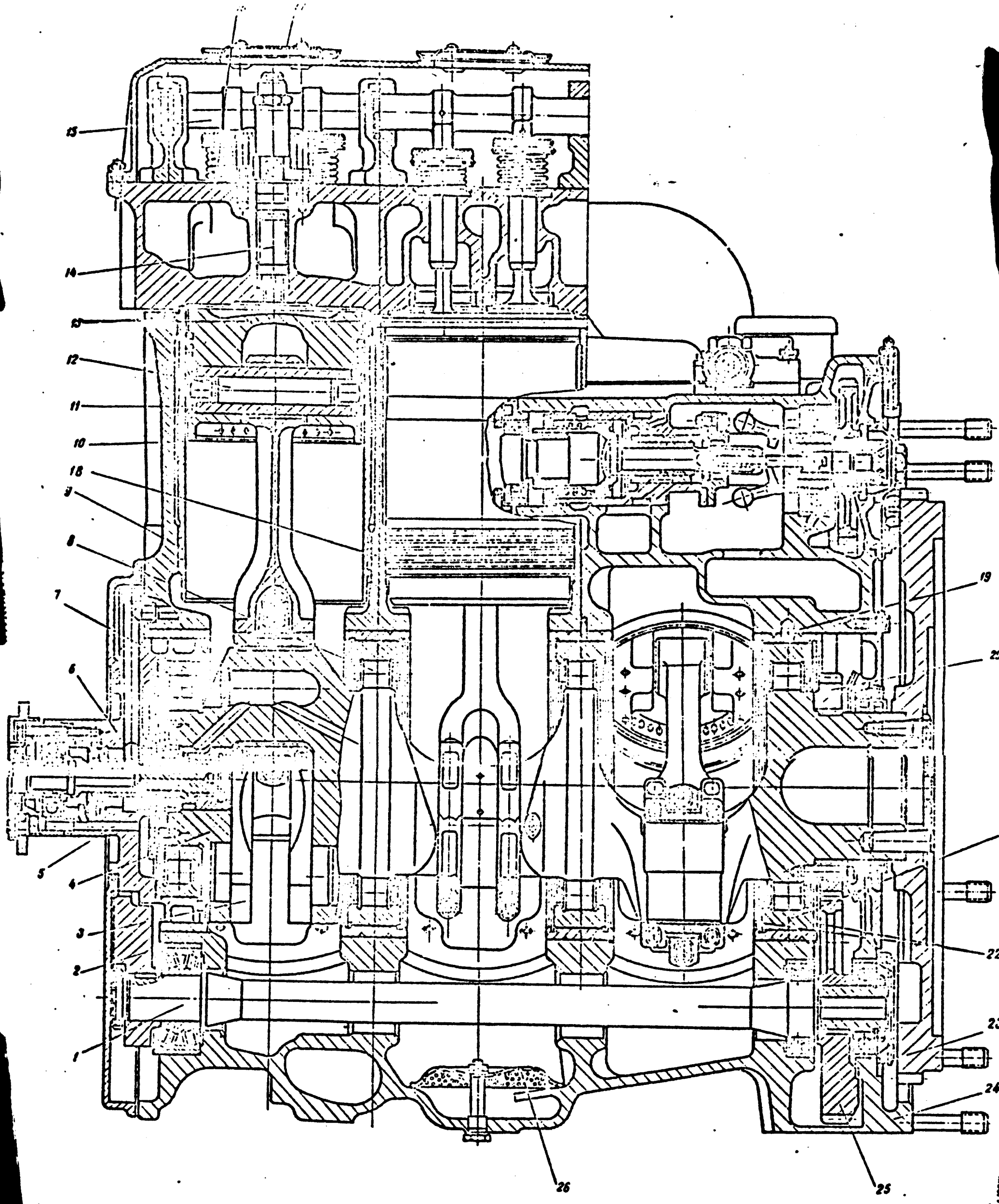

FIG.134. ENGINE (LONGITUDINAL SECTION)

1 - balancing mechanism shaft; 2 - balancing mechanism counterweight; 3 - crankshaft counterweight; 4 - crankshaft; 5 - crankshaft end; 6 - first bearing sleeve; 7, 8 - roller bearings of crankshaft supports. 9 - cylinder liner sealing ring. 10 - cylinder liner; 11 - cooling space; 12 - piston pin; 13 - liner shoulder; 14 - injector; 15 - camshaft; 16 - valve spring; 17 - cover; 18 - crankcase partition; 19 - lockpin; 20 - gear of accessory drive; 21 - bearing race; 22 - locking rings; 23 - flywheel; 24 - crankcase flange; 25 - couterweight; 24 - oil settler filtering gauze

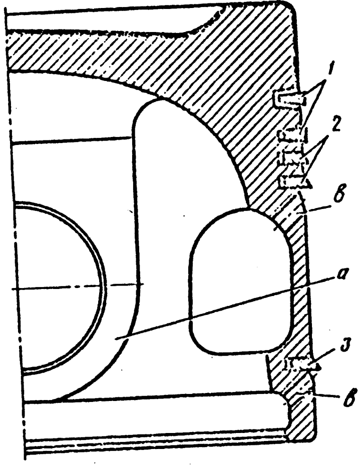

FIG. 142. PISTON

1 - upper compression piston rings; 2 - middle combination piston rings; 3 - lower oil piston ring; a - boss; b - oil drain holes

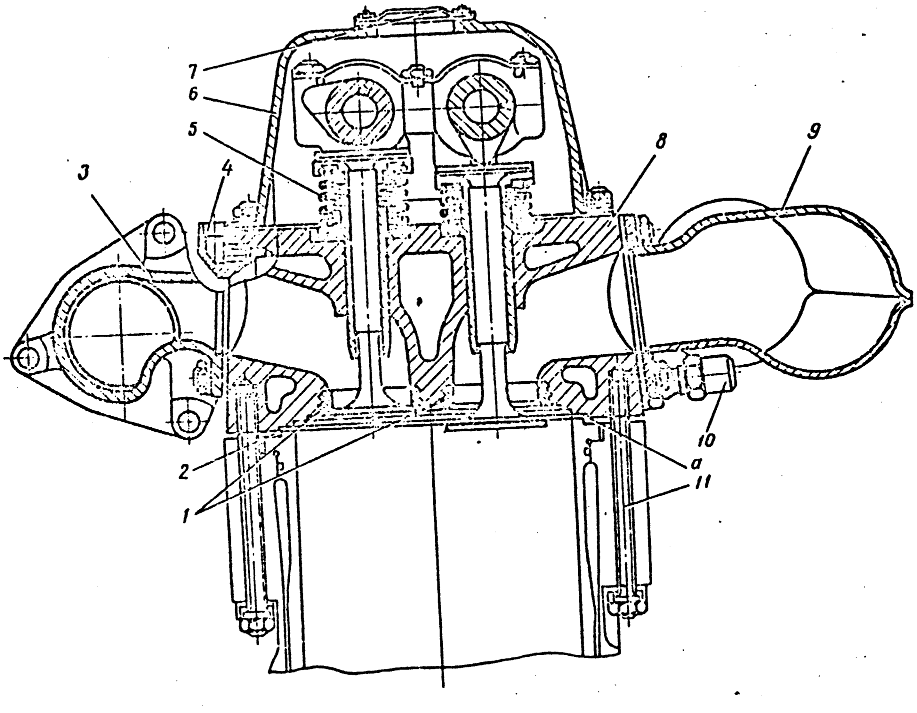

FIG. 143. CYLINDER HEAD

1 - valve seats; 2 - gas joint packing ring; 3 - exhaust manifold; 4 - steam release elbow; 5 - guide bushing; 6 - cylinder head cover; 7 - cover of access hole; 8 - cylinder head; 9 - intake manifold; 10 - air starting valve; 11 - coupling stud; a - cylinder liner shoulder

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and Exhaust Manifolds

Intake manifold 9 (Fig. 143) is secured by studs to the outside surface of the cylinder head. The joint between the manifold flanges and the cylinder head is packed with a ferro-asbestos gasket.

The manifold consists of two stamped halves welded together. Provided on the manifold side surface is a flange with twelve holes for passage of the manifold attaching studs. Welded in the manifold lower part is a boss with a threaded hole closed with a plug. The h serves for draining of lubricant penetrating into the manifold from the intake ports of t cylinder head during preservation of the engine.

Exhaust manifold 3 is cast from heat-resisting cast iron and is stud-attached to the cylinder head side surface in the space between the cylinder blocks. The joint between the manifold flanges and cylinder head is packed with copper-asbestos gaskets. The manifold is terminated with a triangular flange for connection to the exhaust pipe.

Valve Timing Gear

The valve timing gear (Fig. 144) is intended for filling the cylinders with air and cleaning them of the exhaust gases in conformity with the engine working cycle. The valve timing gear is mounted on the cylinder head and consists of the intake and exhaust valves with the discs, springs and locks and the camshafts with drive gears.

The intake and exhaust valves differ from one another in the dimensions of the valve heads and material. The exhaust valve head is of a smaller diameter and is manufactured of heat-resisting steel.

Made in valve stem 13 is a threaded hole accommodating screwed-in disc 17. The threaded connection allows the required clearance between the valve disc and the camshaft cam lobe to be set when adjusting the valve timing.

The valve disc is locked in position by lock 16. The lock is pressed with its butt end teeth to identical teeth of the disc by two coaxial springs 14 and 15 of the valve.

Intake camshaft 8 and exhaust camshaft 7 are mounted in four bearings on the cylinder head upper surface.

At the ends the camshafts carry gears 5 that are meshed with each other.The gear mounted on exhaust camshaft 7 is rotated by the intermediate drive gear. Gears 5 are coupled with the camshafts by adjusting bushings 4 and are pressed to the thrust shoulders of the shafts with nuts 2. The nuts are locked against spontaneous unscrewing with locking ring 3. The adjusting bushing has triangular splines on the outside and square splines on the inside. The splines are designed for adjustment of valve timing. Adjusting bushing 4 is connected with nut 2 by locking ring 12, by means of which the bushing is disengaged from the shaft and gear when the nut is unscrewed.

Each camshaft has six cams. The profile of the intake and exhaust camshaft cams is identical.

The camshafts are made hollow (Fig. 145); the channel inside is intended for passage of oil. For feeding oil to the bearings,drilled in each bearing journal "e" is hole "d". Drilled in the backs of the cams are holes for lubrication of the cams and valve discs 3. From the camshaft front end the oil channel is closed with stopper 1, which is locked with a spring lock.

Oil is supplied to the camshafts through duct "f" in axle 4 of intermediate gear 5, vertical duct "b" in the cylinder head and ducts in thrust bearing 2.

Accessory Drive

The accessory drive is arranged in a shaped pocket of the cylinder block-and-crankcase unit from the flywheel side. The mechanism general view is shown in Fig. 146.

All gears of the accessory drive are spur gears.

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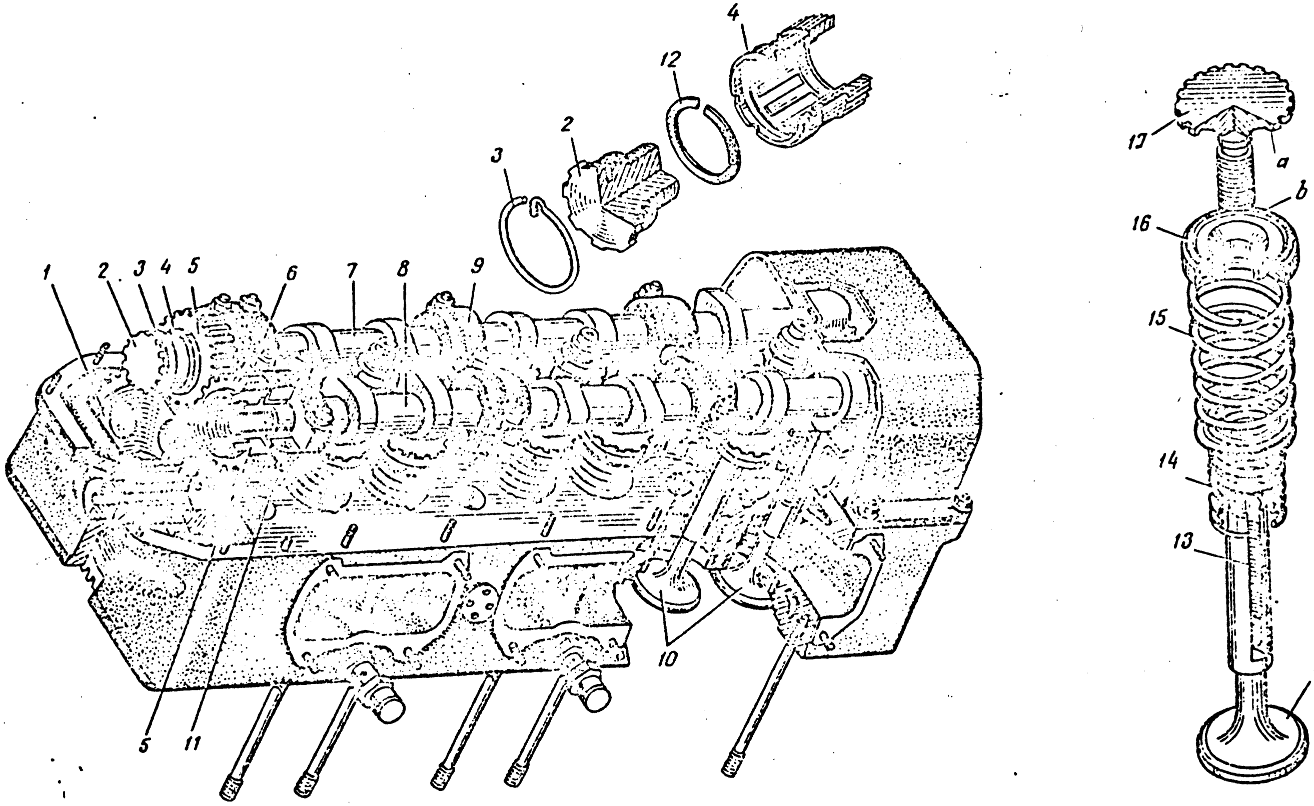

FIG.144. VALVE TIMING GEAR.

1 - valve timing drive gear; 2 - adjusting bushing nut; 3 - locking ring; 4 - adjusting bushing; 5 - camshaft gear; 6 - thrust bearing cover; 7 - exhaust camshaft; 8 - intake camshaft; 9 - camshaft bearing cover; 10 - intake valves; 11 - thrust bearing base; 12 - locking ring; 13 - stem; 14 - smaller spring; 15 - larger spring; 16 - lock; 17 - disc; a, b - cuts; c - valve mushroom

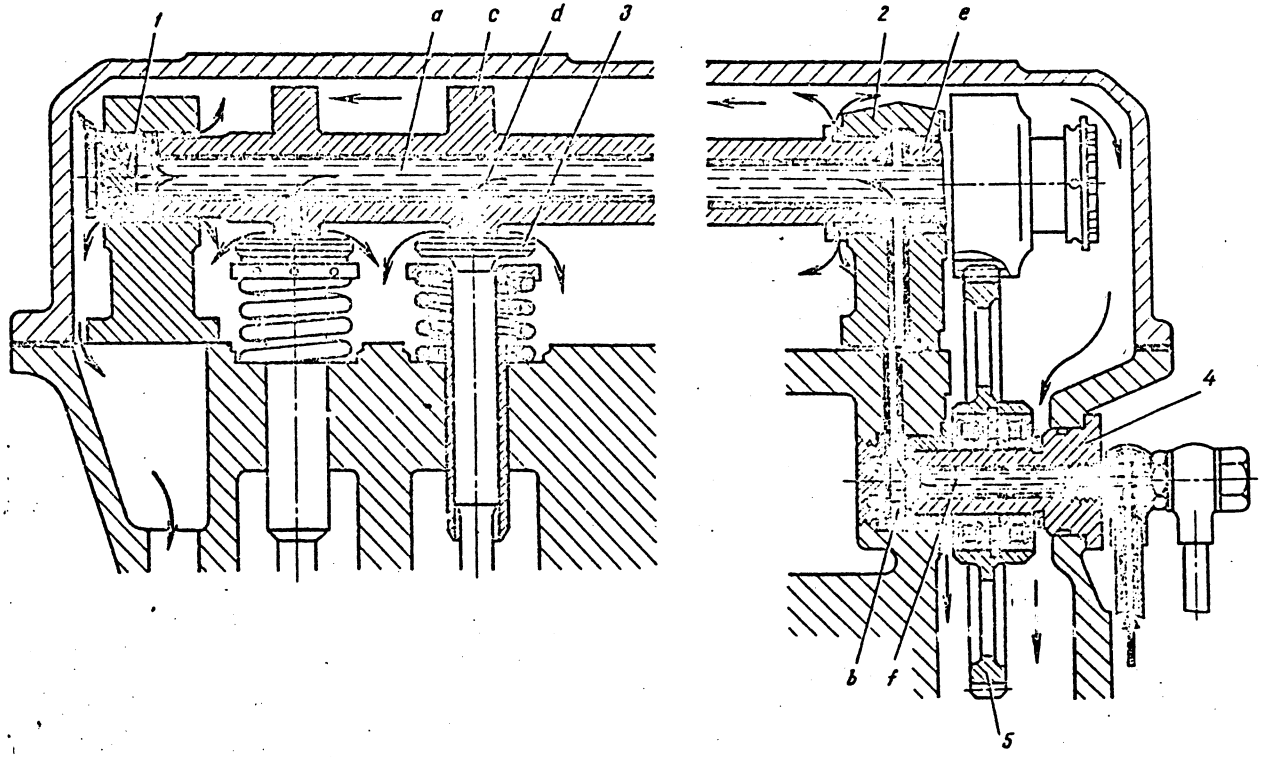

FIG.145. DIAGRAM OF VALVE TIMING GEAR LUBRICATION

1 - camshaft stopper; 2 - thrust bearing; 3 - disc; 4 - intermediate gear axle; 5 - gear; a - central duct; b - oil supply ducts; c - cam; d - hole; e - camshaft bearing journal; f - duct

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Engaged directly with crankshaft gear 3 is balancing mechanism gear 1, intermediate gear 5 transmitting rotation to oil and water pump gear 6, and large gear of cluster gear 16.

From the large gear of cluster gear 16 through two intermediate gears 17 and 18 rotation is transmitted to generator and fan drive gear 19. From the smaller gear of the cluster gear, rotation is transmitted through intermediate gear 12 to cluster gear 13 and fuel pump drive gear 11. The air distributor shaft is key-joined with cluster gear 13. Gears 15 of L.H. cylinder bank camshafts are connected with the smaller gear of cluster gear 13 through intermediate gear 14.

Fuel pump drive gear 11 is connected with camshaft gears 7 of the R.H. cylinder bank by intermediate gears 10 and 8 and cluster gear 9 which drives the tachometer generator shaft.

Generator Drive Clutch

The generator drive clutch (Fig. 147) is assembled in the shaped lug of cylinder block-and-crankcase unit 18. It consists of hollow cylinder-shaped housing 19, rotating in two antifriction bearings 7 and 13, shaft 16 with internal splines "b" for connection with generator resilient shaft and six rubber keys 14.

Accessory drive gear 19 (Fig. 146) through an intermediate gear rotates gear 10 (Fig. 147) which is made en block with housing 19. Fitted over the splines on one end of housing 19 is fan 2 secured by nut 4; generator drive shaft 16 is freely fitted in its space from the other end. Housing 19 and shaft 16 are interconnected by means of six cylindrical rubber keys 14 which serve as a damper.

Rotation is transmitted from shaft 16 to the generator through a resilient shaft connected with shaft 16 by means of splines. The resilient shaft adds to damping of the dynamic loads, appearing at sharp variation of the engine speed.

6.3. FUEL FEED SYSTEM

6.3.1. Purpose and Components

The fuel feed system (Fig. 148) is designed for storing the carried-on amount of fuel, cleaning it before delivery into the engine cylinders, and injection into the combustion chambers.

The system comprises three fuel tanks 13, 19, 20, fuel feed pump (БЦН) 12, coarse fuel filter 3, fine fuel filter 7, engine fuel feed pump 8, high-pressure fuel injection pump, variable-speed governor, fuel injection advance angle setting coupling, six injectors, a fuel return system, pipelines, and two cocks 4 and 5.

6.3.2. Fuel Tanks

The fuel tanks have a total filling capacity of 462 l.

Main fuel tank 13 is located in the troop compartment along the vehicle longitudinal axis and divides the compartment into two halves.

The tank (Fig. 149) has trapezoidal cross-section; it is attached to vehicle bottom 27 by means of lugs 28. Provided on the tank side wall near the bottom is a round access hole with a flange, to which the flange of fuel feed pump (БЦН) 12 is attached. The pump is closed with a rubber boot. Mounted in the tank bottom is drain disc valve 9 pressed by spring 29. The valve access hole is closed from below with plug 22.

Under the valve in the vehicle bottom there is a round access hole, closed with armour plug 25. Welded inside the tank are transverse partitions 8 with round holes.

The partitions are designed to reduce splashing of fuel during the vehicle movement. Filler neck 6 union is welded on top of the tank; the union is connected with the filler

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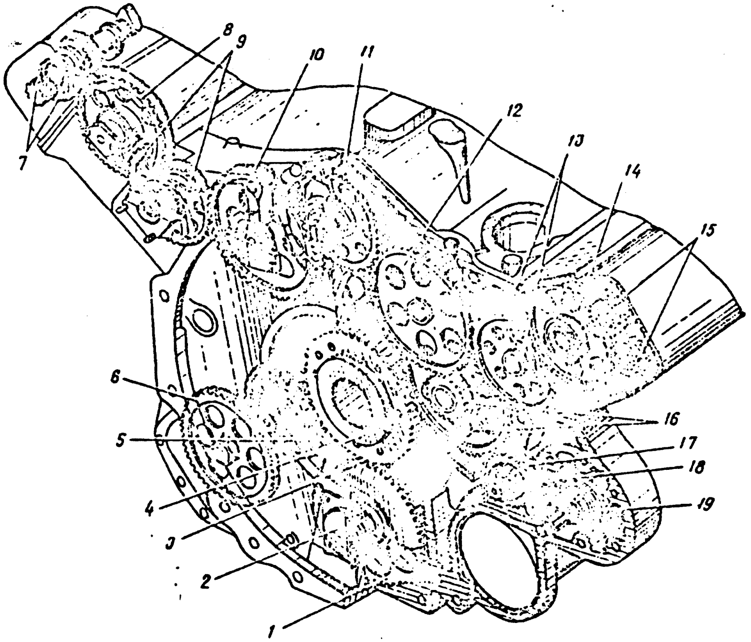

FIG.146. ACCESSORY DRIVE

1 - balancing mechanism gear; 2 - bearing cap; 3 - crankshaft gear; 4 - crankshaft; 5, 10, 12, 17, 18 - intermediate gears; 6 - oil and water pump drive gear; 7 - camshaft gears of R.H. cylinder bank; 8 - intermediate gear of R.H. cylinder bank camshafts; 9 - cluster gear (tachometer drive); 11 - fuel pump drive gear; 13 - cluster gear (air distributor drive); 14 - intermediate gear of L.H. cylinder bank camshafts; 15 - driven gears of L.H. cylinder bank camshafts; 16 - cluster gear; 19 - generator and fan drive gear

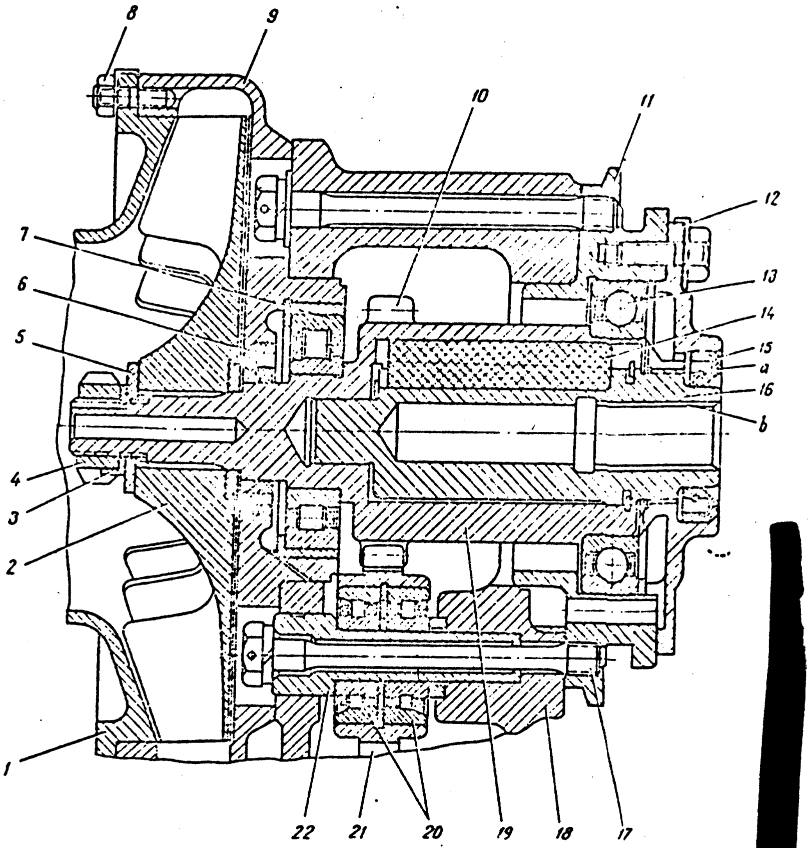

FIG.147. GENERATOR DRIVE CLUTCH

1 - fan cover; 2 - generator cooling fan; 3 - lock washer; 4 - nut; 5 - washer; 6 - packing; 7 - roller bearing; 8 - nut; 9 - fan housing; 10 - gear; 11 - sleeve; 12 - cover; 13 - ball bearing; 14 - rubber key; 15 - packing; 16 - generator drive shaft; 17 - coupling bolt; 18 - engine cylinder block-and-crankcase unit; 19 - hollow cylinder-shaped housing; 20 - bearings; 21 - intermediate generator drive gear; 22 - intermediate gear axle; a - oil control thread; b - splines for connection with generator resilient shaft

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neck arranged on the vehicle roof union is joined with the access hole in the bottom by similar hose 23; thereby the tank has a possibility of slight movement relative to the vehicle hull without breakage of the filler necks.

The main tank is connected with the two tanks arranged in the rear doors by two pipelines; the unions of the pipelines are welded into the lower part of tank side walls. Besides, the tanks are connected by drain pipes 5. Welded in the tank front wall from below is a union for connection of pipe 10 running to fuel level indicator 2.

Fuel level indicator 2 is an organic glass pipe fitted in a metal casing. The casing is graduated; each graduation mark corresponds to 50 l. With its eyes the casing is secured to the conveyer guard post in front of the main fuel tank.

Rear tanks 19, 20 (Fig. 148) are actually the cavities between the rear doors and shaped plates welded to them from inside.

In the bottom part of the tanks there are round access holes closed with covers 21 and intended for cleaning the tanks. The bottom unions of the tanks are joined with the pipelines running to the main tank by means of flexible pipelines 36, which allow opening of the doors. Welded on the outside of the tanks are the filler neck unions accommodating the filtering gauzes. The unions are closed with plugs.

The drain pipe unions terminate inside the tanks in the pipes which are bent upwards; this arrangement prevents penetration of fuel in them.

Mounted on drain pipeline 37 is the valve, which prevents rarefaction in the tanks as the fuel is spent.

At rarefaction in the tanks the disc valve opens, compressing the spring and letting air into tanks. Fuel is drained from the rear tanks through drain valve 29 of the main tank.

6.3.3. Fuel Cocks

The fuel cock (Fig. 150) serves to cut the fuel tanks in and off. The cock consists of body 6, disc valve 5 installed on rod 3, spring 7, eccentric 1 and handle 2 with spring retainer 10. As handle 2 is turned, eccentric 1 moves over the end face of body 6 and pulls rod 3 and valve 5 through axle 9, thus opening passage of fuel from the tanks into the system. Cock 50 (Fig. 6) is mounted on the engine compartment bulkhead lower part on the driver's right.

Cock 47 of the preheater fuel system is installed in the driving compartment on the engine compartment bulkhead lower part on the driver's right.

It consists of body 1 (Fig. 151) and locking needle 4. Needle 4 is screwed in and out by the body thread and opens or closes access of fuel to the preheater boiler pump through union 3.

The fuel is delivered to the cock from the pipeline after the coarse cleaning filter via union 2; when the preheater is inoperative, the fuel is passed from the cock into the same pipeline via union 5. When locking needle 4 is screwed up (clockwise) until stop, it closes the duct of union 3 and fuel circulates through the cock body without getting to the preheater. To feed fuel to the preheater pump, one should unscrew locking needle ring 8 until seat "a" closes the outlet to union 5 by its tapered surface.

6.3.4. Fuel Feed Pump БЦН

Fuel feed pump БЦН (Fig. 152) serves for delivery of fuel from the tanks into the fuel system and for bleeding of air from the system. It is driven by electric motor 12 forming one unit with the pump.

The pump incorporates body 10, impeller 5 fitted over key 3 on electric motor shaft 6, cover 4 and propeller 2.

Aluminium body 10 is bored from one side for fitting onto the electric motor body and has an inner boring accommodating motor shaft ball bearing 19, labyrinth seal bushing 11 and

[redacted]

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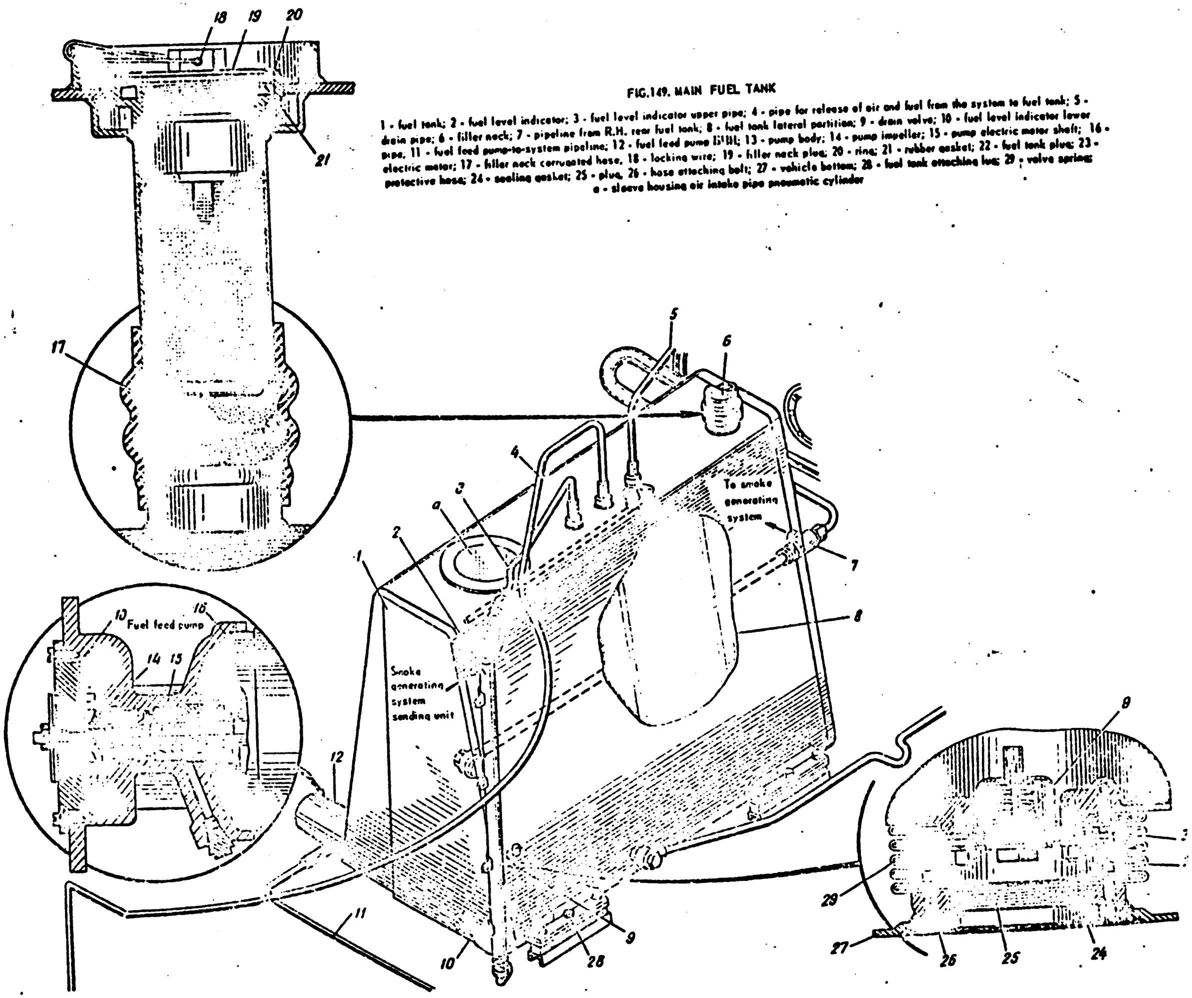
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21
17
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6
4
3
a
2
1
To smoke generating system
7
8
Fuel feed pump
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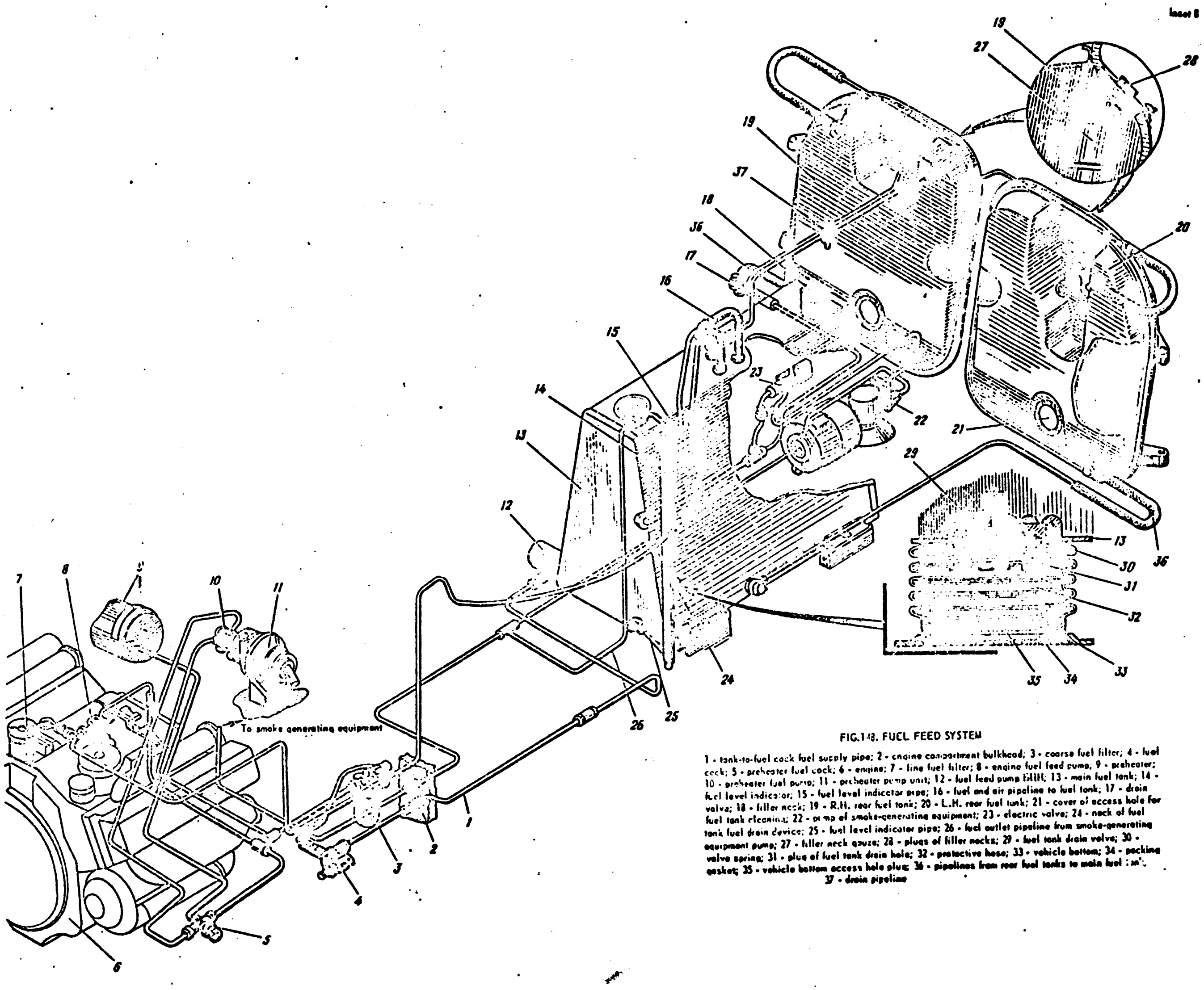
16
14
15
Smoke generating system sending unit
12
11
10
28
9
29
27
26
25
24

FIG.149. MAIN FUEL TANK

1 - fuel tank; 2 - fuel level indicator; 3 - fuel level indicator upper pipe; 4 - pipe for release of air and fuel from the system to fuel tank; 5 - drain pipe; 6 - filler neck; 7 - pipeline from R.H. rear fuel tank; 8 - fuel tank lateral partition; 9 - drain valve; 10 - fuel level indicator lower pipe; 11 - fuel feed pump-to-system pipeline; 12 - fuel feed pump [illegible]; 13 - pump body; 14 - pump impeller; 15 - pump electric motor shaft; 16 - electric motor; 17 - filler neck corrugated hose, 18 - locking wire; 19 - filler neck plug; 20 - ring; 21 - rubber gasket; 22 - fuel tank plug; 23 - protective hose; 24 - sealing gasket; 25 - plug, 26 - hose attaching bolt; 27 - vehicle bottom; 28 - fuel tank attaching lug; 29 - valve spring;
a - sleeve housing air intake pipe pneumatic cylinder

[redacted]

Inset 8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34
33
To smoke generating equipment
26
25
1
2
3
4
5
6

FIG.143. FUEL FEED SYSTEM

1 - tank-to-fuel cock fuel supply pipe; 2 - engine compartment bulkhead; 3 - coarse fuel filter; 4 - fuel cock; 5 - preheater fuel cock; 6 - engine; 7 - fine fuel filter; 8 - engine fuel feed pump; 9 - preheater; 10 - preheater fuel pump; 11 - preheater pump unit; 12 - fuel feed pump filter; 13 - main fuel tank; 14 - fuel level indicator; 15 - fuel level indicator pipe; 16 - fuel and air pipeline to fuel tank; 17 - drain valve; 18 - filler neck; 19 - R.H. rear fuel tank; 20 - L.H. rear fuel tank; 21 - cover of access hole for fuel tank cleaning; 22 - pump of smoke-generating equipment; 23 - electric valve; 24 - neck of fuel tank fuel drain device; 25 - fuel level indicator pipe; 26 - fuel outlet pipeline from smoke-generating equipment pump; 27 - filler neck gauze; 28 - plugs of filler necks; 29 - fuel tank drain valve; 30 - valve spring; 31 - plug of fuel tank drain hole; 32 - protective hose; 33 - vehicle bottom; 34 - packing gasket; 35 - vehicle bottom access hole plug; 36 - pipelines from rear fuel tanks to main fuel tank;
37 - drain pipeline

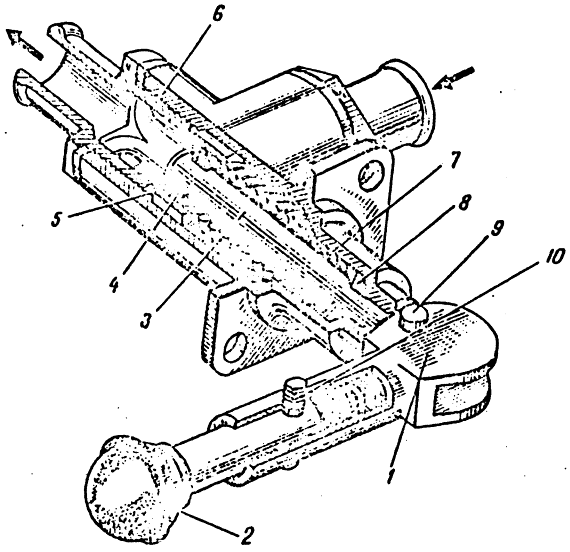

FIG. 150. FUEL COCK

1 - eccentric; 2 - handle; 3 - valve rod; 4 - packing; 5 - valve; 6 - cock body; 7 - spring; 8 - packing; 9 - valve lever axle; 10 - retainer

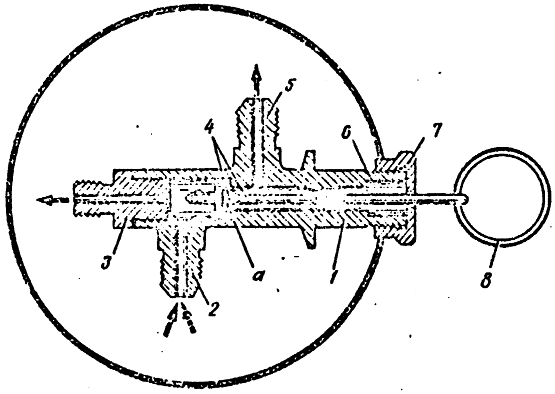

FIG. 151. PREHEATER FUEL COCK

1 - cock body; 2 - fuel supply union from coarse fuel filter; 3 - fuel outlet union to preheater pump; 4 - locking needle; 5 - union for fuel outlet to system; 6 - packing; 7 - union nut; 8 - locking needle ring; a - locking needle seat

[redacted]

[redacted]

cup 8. Made from the body other side is flange 18, bolted to the main tank flange. Secure in the flange is cover 4 with a central hole, which houses propeller 2 mounted flush with the cover surface; the propeller is designed to build up a pressure at impeller 5 inlet. propeller is a blade unit, fitted over the key on the electric motor shaft and secured by nut 1.

Impeller 5 is a disc with eight curvilinear blades bent opposite the direction of ro tion. The pump end surface fitted into the tank is furnished with a filtering gauze. As t pump is arranged in the tank lower part it is always filled with fuel. When the electric tor is switched on, the propeller delivers fuel to the impeller that throws it with its bl from the centre to the periphery, thus building up a pressure in the volute due to action the centrifugal forces. Under the pressure in the volute, the fuel is delivered via the fu pipeline through a cock and coarse fuel filter to the engine fuel feed pump.

6.3.5. Coarse Fuel Filter

The coarse fuel filter (Fig. 153) is installed in the engine compartment near the bu head. It consists of body 5, filtering element 3 and cover 10.

Welded into the body bottom along the axis is boss "a" with a threaded hole receivin central stud 12. Screwed on the other end of the stud is nut 8 pressing cover 10 to body

The filtering element consists of the filtering section made of calibrated band 14 a thin-walled sleeve 4 located inside the section.

From below the filtering element is packed by twin felt packings 1 and 2 pressed wit spring 13, and a felt gasket from above.

Fuel is supplied into the filter through inlet union 6 in the filter cover and gets into the space between filtering element 3 and body 5.

Passing through the slots of the filtering section, fuel is cleaned and via outlet union 9 is delivered to the engine fuel feed pump.

6.3.6. Fine Fuel Filter

The fine fuel filter (Fig. 155) serves for further cleaning of fuel, as well as for bleeding air from the fuel feed system. It is mounted on four studs in the space between the cylinder blocks.

The filter consists of body 5, a filtering element and cover 2 secured to the filter body with coupling bolt 3. A sealing gasket is placed in the cover-to-body joint.

The filtering element consists of cylindrical brass gauze 16 with silk or caprone gauze 15 fitted over it and a set of filtering felt plates 12 divided by caprone (or cardboard) inlet 10 and outlet 11 spacers. The set of the filtering plates and spacers fitted on the metal and silk (caprone) gauze assembly is clamped between plates 13 and 8 with coupling nut 7 screwed on the thread of bushing 9, soldered to which is the other end of gauze 16.

The spaces with filtered and non-filtered fuel are divided by oil seal 6 and felt ring 14. Spring 4 presses the filtering element against felt ring 14 and oil seal 6 - agai the end face of nut 7.

Fuel is supplied to the filter through the middle union and fills the filter space around the filtering element. Under the pressure built up by the fuel feed pump the fuel passes via ports "a" of inlet spacers 10 into spaces "c" and then seeps through felt plates 12 into spaces "b" of outlet spacers 11 and through ports "d", silk and metal gauz gets into the inner space of the filtering element.

From this space fuel passes to the outlet union through a drilling and duct "e".

Air present in the fuel at the entrance into the filter goes upwards, presses off ball 19 of the non-return valve assembled in body 18 and is returned into the tank throug a pipe.

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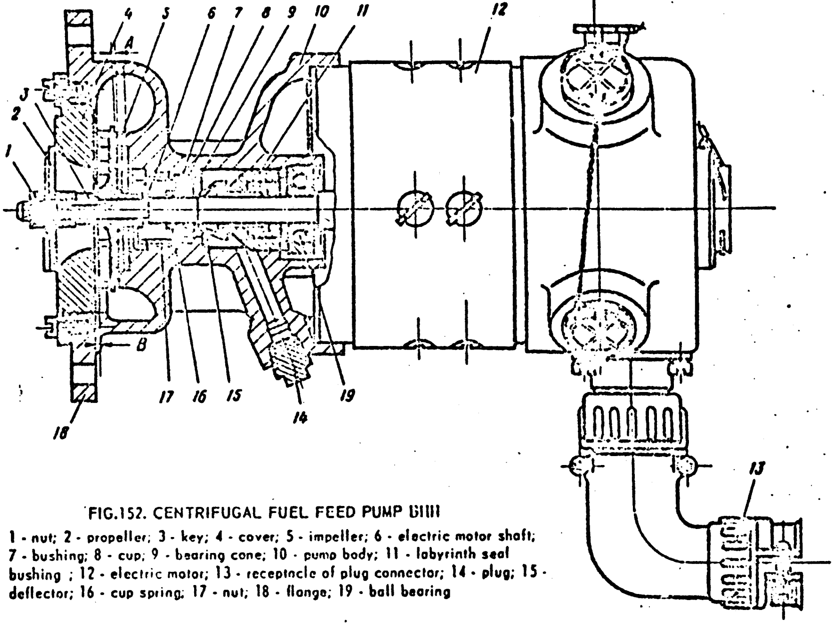
4
5
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A
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2
1
B
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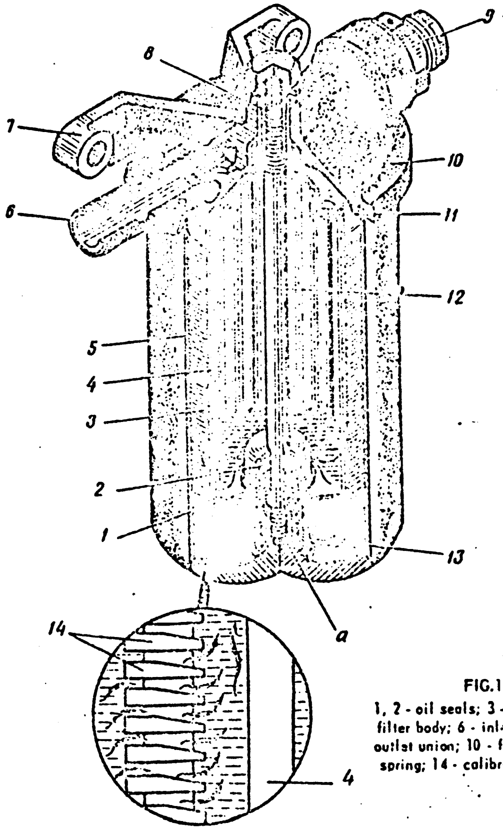
18
13

FIG.152. CENTRIFUGAL FUEL FEED PUMP БНН

1 - nut; 2 - propeller; 3 - key; 4 - cover; 5 - impeller; 6 - electric motor shaft; 7 - bushing; 8 - cup; 9 - bearing cone; 10 - pump body; 11 - labyrinth seal bushing ; 12 - electric motor; 13 - receptacle of plug connector; 14 - plug; 15 - deflector; 16 - cup spring; 17 - nut; 18 - flange; 19 - ball bearing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a
14
4

FIG.153. COARSE FUEL FILTER

1, 2 - oil seals; 3 - filtering element; 4 - filtering element sleeve; 5 - filter body; 6 - inlet union; 7 - filter attaching bracket; 8 - nut; 9 - outlet union; 10 - filter cover; 11 - cover gasket; 12 - central stud; 13 - spring; 14 - calibrated band of filtering element; a - boss

[redacted]

6.3.7. Fuel Feed Pump

Mounted on the engine is fuel feed pump 7 (Fig. 156) of the piston type. The pump is mounted on the fuel injection pump housing on studs and is secured by nuts. The pump is driven by an eccentric of fuel injection pump camshaft 6.

The fuel feed pump consists of aluminium housing 1 (Fig. 154) with steel piston 3 moving in the central hole. The piston is loaded with spring 4, which presses it to rod 1 The rod, in its turn; thrusts against follower 8. The effort of spring 9 is applied to th follower.

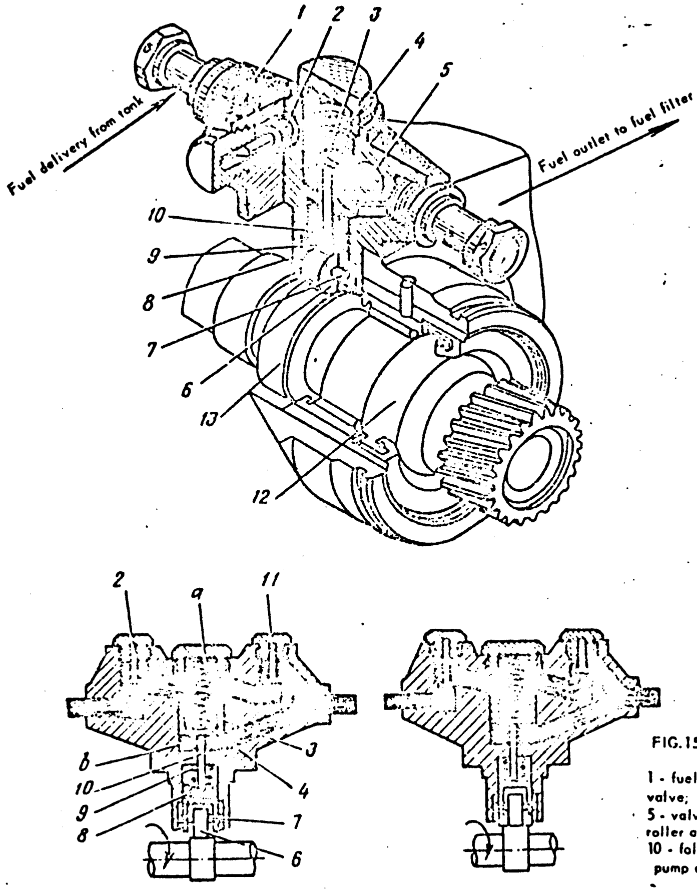

FIG.154. ENGINE FUEL FEED PUMP

1 - fuel feed pump housing; 2 - intake valve; 3 - pump piston; 4 - piston spring; 5 - valve seat; 6 - roller of follower; 7 - roller axle; 8 - follower; 9 - follower spring; 10 - follower rod; 11 - by-pass valve; 12 - pump camshaft; 13 - eccentric; a, b - spaces

The follower is a short cylindrical rod with a forked end. The fork accommodates in it slot roller 6 freely rotating on axle 7. The axle ends fit into the longitudinal slots of the fuel feed pump housing, therefore the follower may displace in the axial direction only

Arranged on both sides of the central channel are intake valve 2 and by-pass valve 11 made of textolite. The valves are pressed with the springs to seats 5. The intake and by-pass valves are interchangeable.

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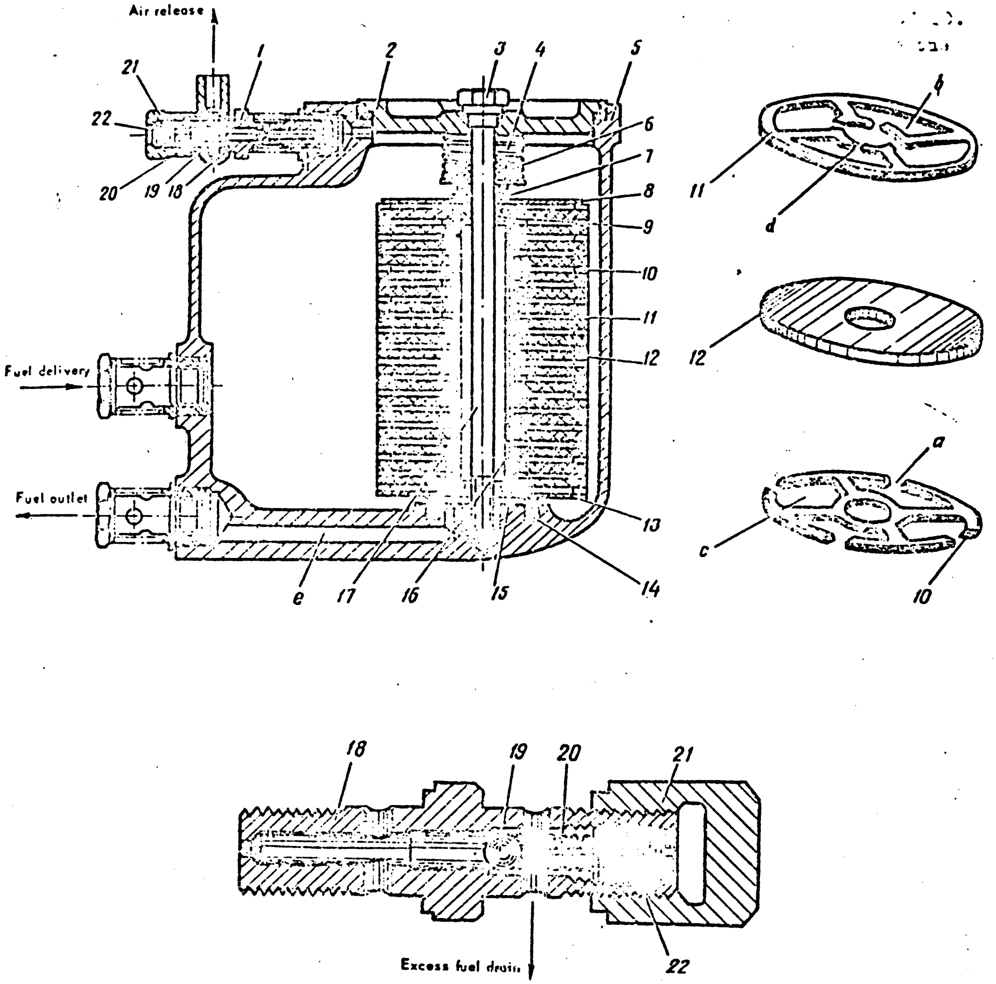
Air release
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Fuel delivery
Fuel outlet
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14
15
16
17
e
b
11
d
12
a
c
10
18
19
20
21
Excess fuel drain
22

FIG.155. FINE FUEL FILTER

1 - non-return valve; 2 - filter cover; 3 - coupling bolt; 4, 20 - springs; 5 - filter body; 6 - oil seal; 7 - nut; 8 - pressure plate; 9 - bushing; 10 - inlet spacer; 11 - outlet spacer; 12 - felt filtering plate; 13 - packing plate; 14 - felt ring; 15 - gauze; 16 - filter metal gauze; 17 - stud; 18 - non-return valve body; 19 - ball; 21 - union nut; 22 - plug; a, d - ports; b, c - spaces; e - duct

[redacted]

The pump operates as follows. As injection pump camshaft 12 rotates, eccentric 13 displaces piston 3 upwards, and spring 4 returns it down when the follower roller leaves the eccentric lobe, thereby the piston performs reciprocating motion. When the piston goes down rarefaction is created in space "a" above the piston and fuel is sucked in it from the supply pipeline via intake valve 2. Simultaneously fuel located under the piston in space "b" is pressed out into the outlet pipeline to the fine fuel filter. As the piston moves upwards pressure built up in space "a" closes intake valve 2 and opens by-pass valve 11 and the fuel from space "a" is delivered through the channel into space "b" where rarefaction occurs during the piston upward motion.

The pump output is considerably larger than the engine fuel consumption under any operating conditions; therefore, fuel delivery to the fuel injection pump is continuous and accumulation of air in the pipelines is prevented. If due to some reason the pressure in space "b" under the piston increases and overcomes the force of spring 4 (1.5 - 1.8 kgf/cm^2), the spring will fail to displace the piston down and the pump will stop pumping fuel until the pressure decreases, thus preventing breakage of the pump parts.

6.3.8. High-Pressure Fuel Injection Pump

General

The fuel injection pump (Fig. 156) is designed for delivery of accurately metered and well-timed portions of fuel at a high pressure to the injector in each cylinder.

The fuel injection pump together with the governor and fuel feed pump is mounted between the cylinder blocks and is attached to the cylinder block-and-crankcase unit by two bolts from the governor side and a hoop from the drive side.

Fuel is supplied to each injector by a separate pump section through a high-pressure pipe.

All the six pump sections are assembled in a common housing and have a common drive.

Pump Design

The fuel pump consists of housing 9, camshaft 6, six pump sections, a governor and a drive.

Housing 9 is a box-like aluminium structure with internal partitions.

Provided in the housing upper part on each pump block are holes for access to fuel feed adjustment mechanism and to the followers. The holes are closed with steel stamped covers 3.

Camshaft 6 is a solid piece having three cams actuating the pump sections and an eccentric driving the fuel feed pump. The shaft rotates in a ball bearing on the governor side and a roller bearing on the drive side mounted in steel sleeves, which are press-fitted in the borings of the housing. Places where the shaft ends protrude from the pump housing are packed with rubber cups.

Each cam of the shaft actuates one section of the right-hand pump block and one section of the left-hand pump block. Every 60° of the camshaft turn fuel is delivered by one of the pump sections.

In the upper part of the pump housing above the camshaft eccentric there is a mounting surface with a hole for installation of fuel feed pump 7. Near this mounting surface there is a hole for filling of slushing grease. Mounted here as well is the slotted filter, through which oil is supplied to the pump from the engine lubrication system.

The filter consists of body 5 and filtering element 4.

Oil, supplied through the slotted filter, lubricates the camshaft bearings and friction parts.

Made in the pump housing blocks are stepped borings (three borings in each pump block) accommodating the followers from the camshaft side and barrels 14 of plungers 12 and delivery valves 44 from the other side.

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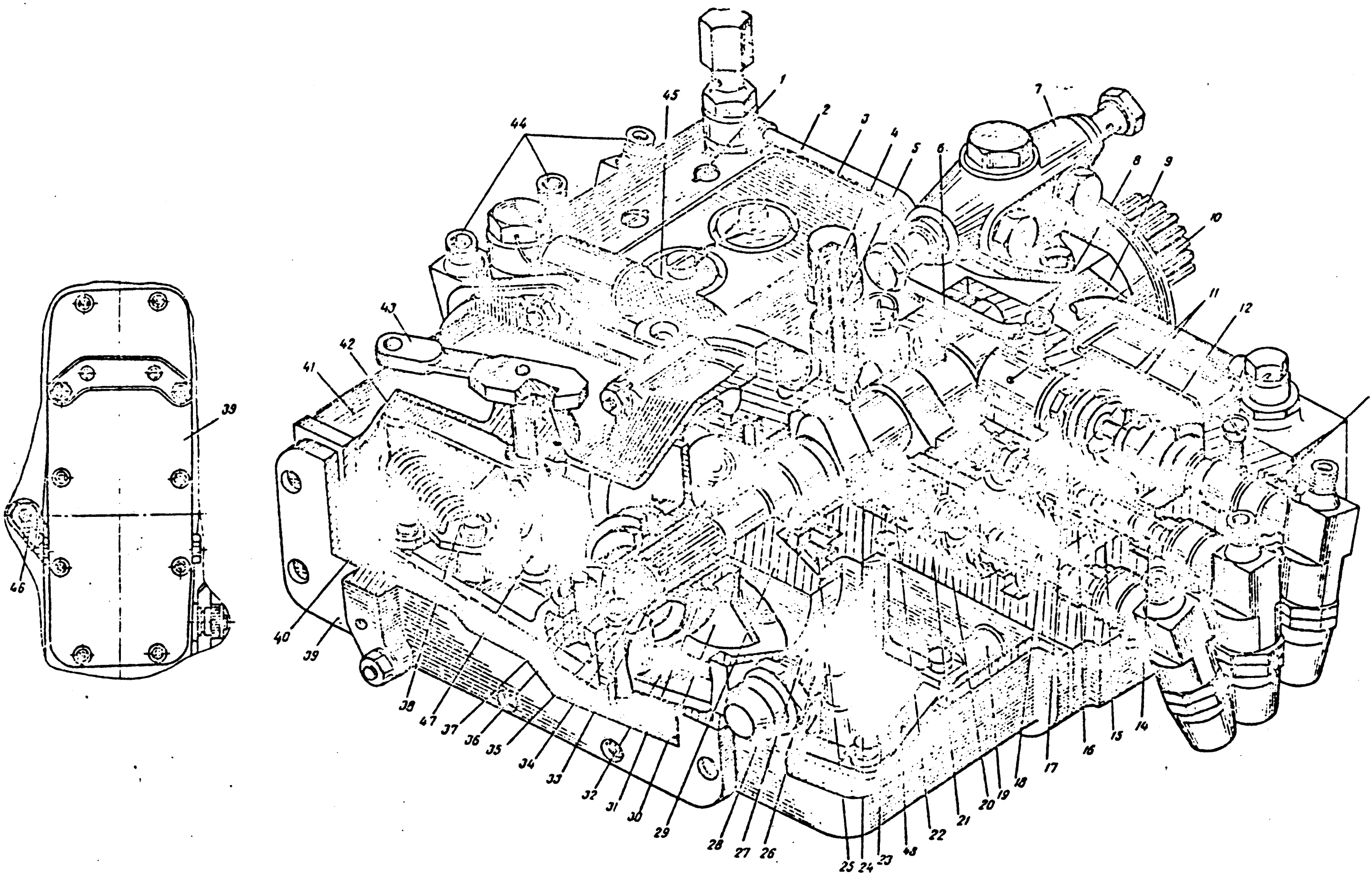
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FIG.156. FUEL INJECTION PUMP

1 - plunger barrel lockscrew; 2 - fuel and air outlet pipe; [illegible] - covers; 4 - filtering element; 5 - oil filter body; 6 - camshaft; 7 - fuel feed pump; 8 - follower lockscrew; 9 - fuel pump housing; 10 - lock-pin; 11 - spring lower discs; 12 - plunger; 13,34 - nuts; 14 - plunger barrel; 15 - toothed rim; 16 - spring upper disc; 17 - swivelling sleeve; 18 - plunger spring; 19 - control rack; 20 - follower [illegible] locknut; 22 - follower roller; 23 - follwer body; 24 - needle bearing; 25 - taper disc; 26,36 - stops; 27 - stop sleeve; 28 - blind nut; 29 - governor crosspiece; 30 - governor disc; 31 - thrust ball bearing; 32 - governor lever; 33 - [illegible]

Drilled in the housing are two longitudinal channels, one of them is intended for feeding fuel to the pump sections, the other channel accommodates the fuel feed control rack.

Drilled above each fuel channel in the housing upper part are two holes. The right-hand hole on the governor side receives a union for fastening the pipeline for supply of fuel from the fuel filter. From the fuel filter fuel is supplied to the fuel channel of the right-hand block. Fuel goes to the fuel channel of the left-hand block via pipeline 45.

Engine operation requires only a portion of fuel supplied by the fuel feed pump. The excess fuel is taken away from the fuel channels via outlet pipe 2.

The fuel feed control mechanism includes toothed control racks 19 which are meshed with toothed rims of swivelling sleeves 17. Lugs of the plunger ends fit into the grooves of the swivelling sleeves.

The control rack is mounted in two bronze bushings, press-fitted into the pump housing. From turning the rack is retained by a lockscrew located on the pump housing lower part; this screw also serves for limiting the maximum displacement of the rack. When the control rack is moved, the swivelling sleeves turn the plungers in barrels, thus varying the amount of fuel injected into the engine cylinders. As the left-hand control rack is moved towards the pump drive and the right-hand one towards the governor, the fuel delivery increases and vice versa.

Rims of the swivelling sleeves are split; this design feature makes it possible to adjust the separate pump sections for uniform fuel delivery.

Connected to the control racks from the governor side are links 38 joined with lever 32 of the governor. The governor lever is connected through governor spring 40 and spring lever 42 with control lever 43 located on the upper wall of governor housing 41.

Operation of Fuel Injection Pump

As the engine crankshaft rotates, it actuates pump camshaft 6. As the shaft rotates, the cams run over rollers 25 (Fig. 157) of the pump sections and displace the followers upwards.

As the follower is displaced upwards, plunger 20 pressed against the end face of follower adjusting bolt 22 by spring 21 moves upwards. When the cam lobe leaves the roller, the plunger and follower go down to the initial position under the action of compressed spring 21.

The side wall of barrel 19 has two through holes "d" (intake and by-pass), that serve for filling space "c" above the plunger with fuel from the fuel channel in the pump housing.

The by-pass hole located on the side of the longitudinal groove on the barrel serves for passage of fuel from the space above the plunger at the moment the fuel delivery is stopped.

As the plunger moves downwards fuel from the moment of opening of barrel intake and by-pass holes is fed from the pump housing fuel channel and fills space "c" above the plunger in the barrel. During the plunger upward stroke fuel is initially pressed out of the barrel through both holes back into the pump fuel channel. As soon as the plunger upper edge shuts off both holes, the pressure starts growing in the above-plunger space and in duct "a" of delivery valve body 1. When the fuel pressure in the above-plunger space becomes high enough to overcome the resistance of spring 6, delivery valve 2 will open and fuel will be forced via duct "b" and a high-pressure pipeline to an injector.

The delivery valve travel is limited by stop 10. Nut 8 serves to adjust the pressure of valve spring 6. Screwed on the nut from the outside is protective cap 11.

Fuel that passes through the clearance between body 1 and valve 2 is drained via pipe 13 into the pump housing.

During further upward motion of the plunger its helical cut-off edge "f" will open the by-pass port in the barrel and the fuel will start flowing through vertical groove "e" and recess "g" into the fuel channel of the pump housing. The pressure above the plunger will

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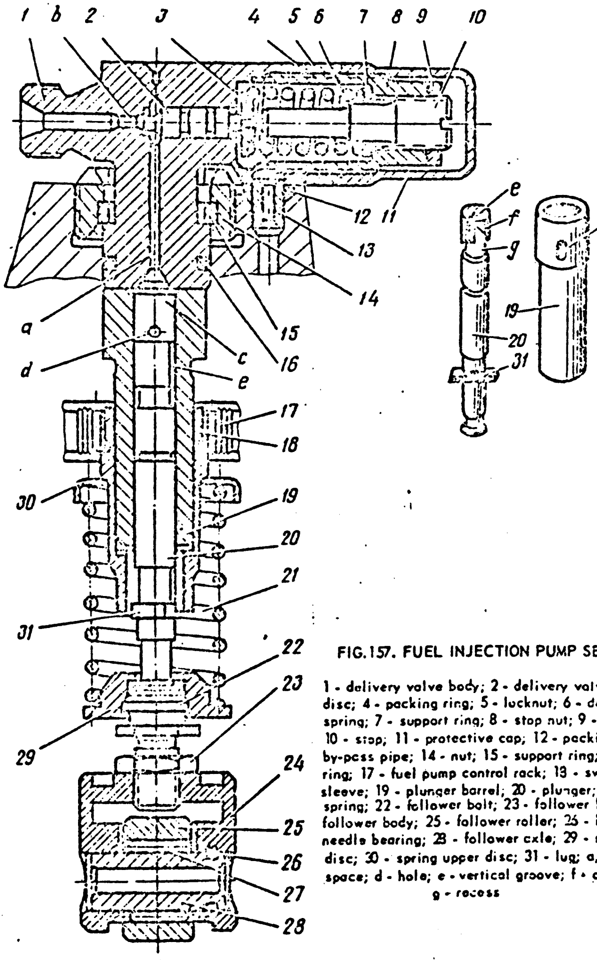
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27
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30
31
a
b
c
d
e
f
g

FIG.157. FUEL INJECTION PUMP SECTION

1 - delivery valve body; 2 - delivery valve; 3 - spring disc; 4 - packing ring; 5 - locknut; 6 - delivery valve spring; 7 - support ring; 8 - stop nut; 9 - stop locknut; 10 - stop; 11 - protective cap; 12 - packing ring; 13 - by-pass pipe; 14 - nut; 15 - support ring; 16 - packing ring; 17 - fuel pump control rack; 18 - swivelling sleeve; 19 - plunger barrel; 20 - plunger; 21 - plunger spring; 22 - follower bolt; 23 - follower locknut; 24 - follower body; 25 - follower roller; 26 - lockpin; 27 - needle bearing; 28 - follower axle; 29 - spring lower disc; 30 - spring upper disc; 31 - lug; a, b - ducts; c - space; d - hole; e - vertical groove; f - cut-off edge; g - recess

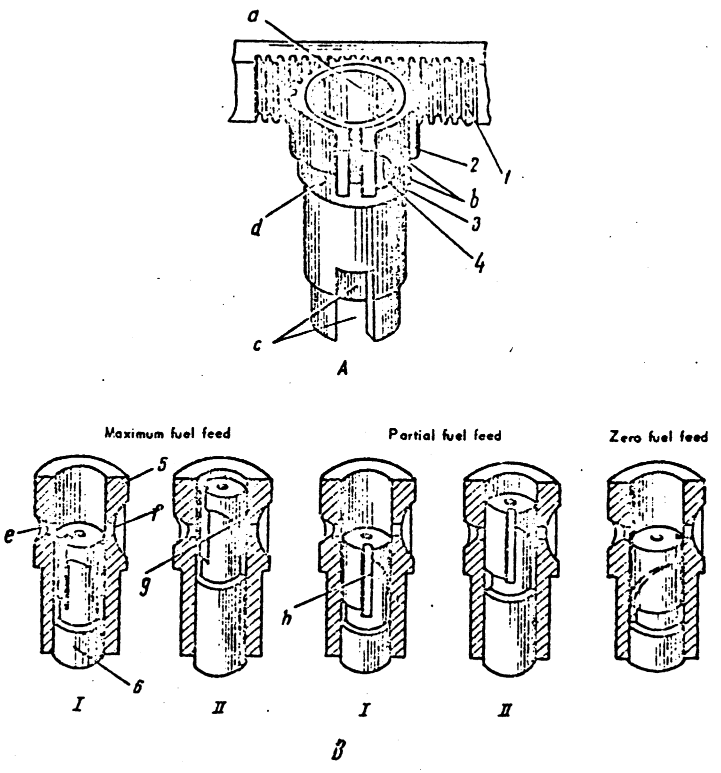
a
1
2
b
3
4
d
c
A
Maximum fuel feed
Partial fuel feed
Zero fuel feed
5
e
f
g
h
6
I
II
I
II
B

FIG.158. PLUNGER SWIVELLING SLEEVE

A - swivelling sleeve; B - diagram of plunger operation; 1 - toothed rack; 2 - toothed rim; 3 - sleeve body; 4 - coupling screw; 5 - plunger barrel; 6 - plunger; a - splines; b - setting notches; c - cutouts for plunger lugs; d - hole for drift; e - fuel inlet hole; f - fuel supply (by-pass) and lockscrew hole; g - plunger cut-off edge; h - vertical groove drop and the spring will close the delivery valve. After reaching the top point, the plunger will start going down and when the intake and by-pass holes in the barrel will become open, the suction stroke of the next cycle will start.

To control the amount of fuel delivery, plunger should be turned by means of lug 31. In case the plunger is turned clockwise, cut-off edge "f" on its surface will open the by-pass hole later and,hence, the amount of fuel delivered by the pump will be increased. When the plunger is turned counterclockwise, the fuel delivery is reduced.

The plunger is turned with the aid of swivelling sleeve 18 that carries toothed rim 2 (Fig. 158) secured to the sleeve by means of screw 4. The plunger lug enters cutouts "c" of the sleeve. Illustrated in the figure are three positions of helical cut-off edge "g" relative to hole "f" of the barrel. The amount of fuel delivered into the engine cylinders is varied by means of turning plungers 6; thereby,the moment of opening by-pass hole "f" by the cut-off edge "g" and, as a result, the moment of the hole communication through the cut-out under the cut-off edge and vertical groove "h" with the space above the plunger is changed, that is, the moment when the fuel delivery ceases is changed.

Thus, the plunger stroke and the beginning of fuel delivery remain unchanged and only the end of fuel delivery is varied depending on the position of cut-off edge "g".

The plunger and the barrel, as well as the delivery valve and its body are lapped to each other in pairs and may be replaced only as a set.

6.3.9. Variable Speed Governor

Purpose

The governor is a mechanical variable speed centrifugal type. The purpose of the governor is to maintain stable idling speed, to prevent engine racing when the load is abruptly decreased and to maintain the set speed within certain limits under different loads.

Governor Design

The governor is assembled in the pump housing on the camshaft end and makes one assembly together with the pump. It consists of taper disc 25 (Fig. 156) freely fitted on the camshaft, crosspiece 29 fitted over the camshaft splines, five balls (weights) 33, flat disc 30, thrust ball bearing 31, stop 36, roller 10 (Fig. 159) and a control linkage. Spring 12 through governor lever 11 and roller 10 presses flat disc 7 to balls 6 that thrust from the other side against taper disc 5.

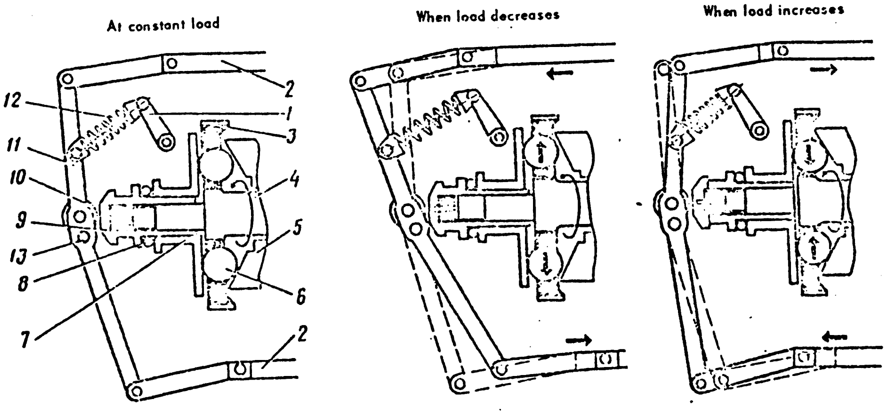

FIG.159. GOVERNOR OPERATION DIAGRAM

1 - spring lever; 2 - toothed rack; 3 - governor crosspiece; 4 - camshaft; 5 - taper disc; 6 - governor ball; 7 - governor disc; 8 - thrust ball bearing; 9 - stop; 10 - roller; 11 - governor lever; 12 - spring; 13 - lever axle

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[redacted]

Lever 11 is mounted on axle 35 (Fig. 158) and the fuel injection pump control racks. Installed on an axle in the lever slot is roller 37 rotating on a needle bearing.

Governor lever 32 is connected by spring 40 with lever 42 secured on the axle of fuel feed control lever 43.

Made on control lever 43 are special bevels; the zero fuel feed and maximum speed adjusting screws thrust against these bevels. These screws are turned into the lug on the governor housing and are locked in position with locknuts and lock washers.

Maximum fuel feed stop 26 is turned into threaded sleeve 27 on the front wall of the governor housing. The stop contacts the vertical lug of the governor lever. Upon adjustment this stop is secured with nut 28 and a seal is put on it.

The governor parts are lubricated with oil filled in the governor housing. The oil level may be checked with the aid of a dipstick screwed into a threaded hole provided on the upper wall of the governor housing. The two marks provided on the dipstick correspond to th maximum and minimum oil level in the governor housing. Oil is drained through a plugged hol located in the horizontal lug in the housing lower part.

Governor Operation

When starting the engine,the driver depresses the fuel feed pedal and turns control lever 43 with the help of the control linkage. Lever 43 turning on axle 47 actuates lever 42 mounted on the same axle and expands spring 40. The other end of spring 40 actuates lever which turns around axle 35 and displaces fuel injection pump racks 19 through links 48 and 38, thus ensuring delivery of the required amount of fuel.

During the engine operation the pump camshaft and crosspiece 3 (Fig. 159) rotate. The crosspiece drives along balls 6.

As the speed grows, the balls under the effect of increasing centrifugal forces withdraw from the center of rotation and, moving on taper disc 5, push flat disc 7 together wit ball bearing 8 and stop 9.

Lever 11 turning on axle 13 displaces the control racks towards decrease of fuel delivery. With the decrease of fuel delivery the crankshaft speed is reduced causing a reductic of the governor crosspiece speed of rotation. The balls centrifugal force is reduced and th expanded spring actuates the lever and moves the control racks again towards increase of fu delivery. With a steady state duty of the engine the centrifugal forces of the balls are balanced by tension of the expanded spring.

To prevent sharp variation of speed in case of abrupt change of load,the crosspiece grooves are arranged at an angle to the radial direction.

Thus, during the engine operation the governor automatically maintains the set crankshaft speed, moving the control racks towards increase or decrease of fuel delivery.

6.3.10. Injector

Injector (Fig. 160) is of a closed type with multihole spray tip. The injector is designed for delivery of equal amounts of fuel in atomized condition to the combustion chamb and for uniform distribution of fuel.

The injectors are mounted in the cylinder head along the axes of the cylinders, being secured on the cylinder head upper surface with studs and nuts. Placed between the injecto and injector well bottom in the cylinder head is copper packing ring 11.

The injector consists of body 5, spray tip nut 7, spray tip with needle, a slotted filter, stem 6 with spring 4 and spring nut 1.

The injector body has a through drilling accommodating stem 6 and spring 4. Screwed into the body inner thread is nut 1 pressing spring 4 to the stem. Screwed on the outer thread of the body is spray tip nut 7 housing the slotted filter and spray tip body 10 wit

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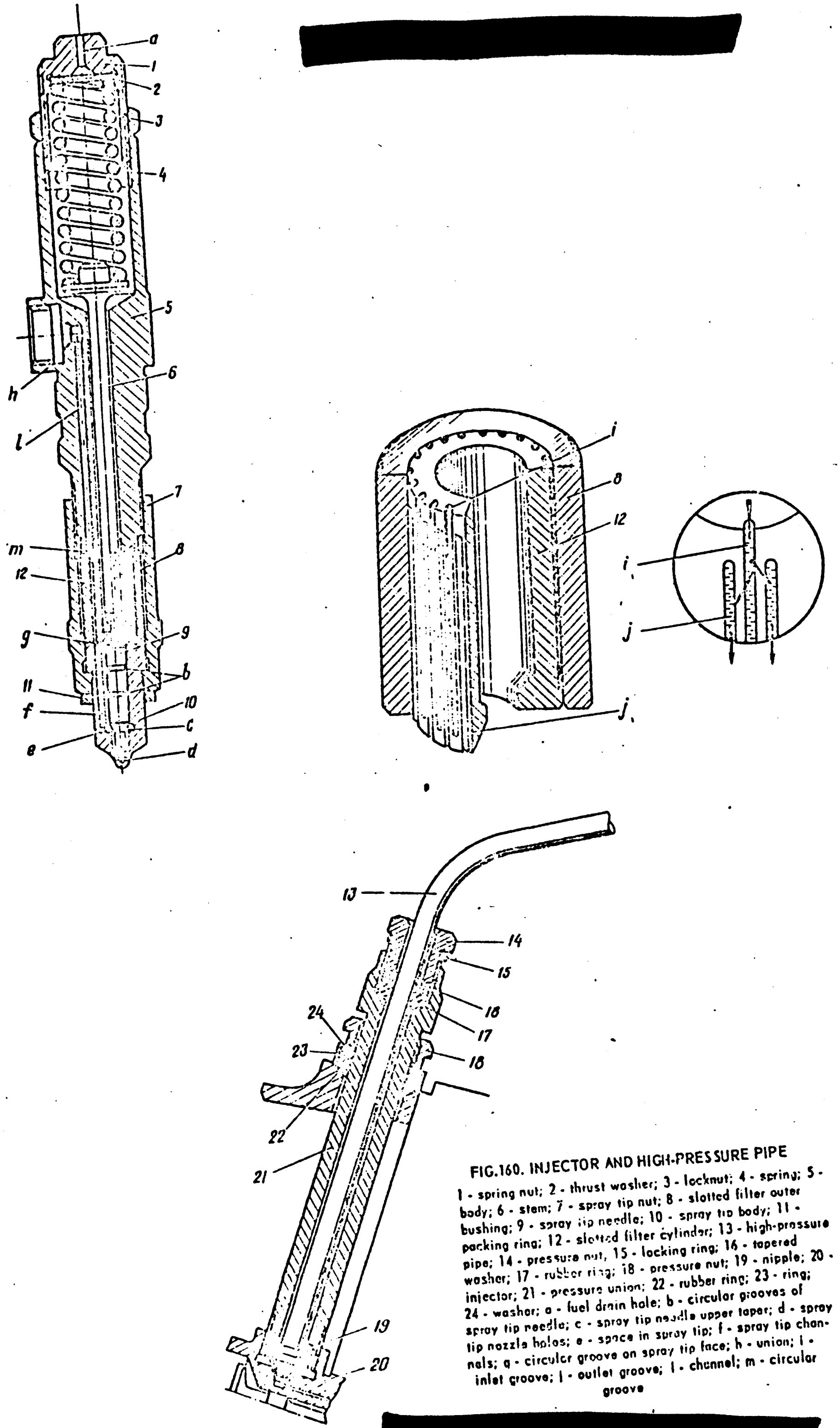

FIG.160. INJECTOR AND HIGH-PRESSURE PIPE

1 - spring nut; 2 - thrust washer; 3 - locknut; 4 - spring; 5 - body; 6 - stem; 7 - spray tip nut; 8 - slotted filter outer bushing; 9 - spray tip needle; 10 - spray tip body; 11 - packing ring; 12 - slotted filter cylinder; 13 - high-pressure pipe; 14 - pressure nut, 15 - locking ring; 16 - tapered washer; 17 - rubber ring; 18 - pressure nut; 19 - nipple; 20 - injector; 21 - pressure union; 22 - rubber ring; 23 - ring; 24 - washer; a - fuel drain hole; b - circular grooves of spray tip needle; c - spray tip needle upper taper; d - spray tip nozzle holes; e - space in spray tip; f - spray tip channels; g - circular groove on spray tip face; h - union; i - inlet groove; j - outlet groove; l - channel; m - circular groove

[redacted]

needle 9. The mating butt ends of the injector body, slotted filter outer bushing 8 and the spray tip body are carefully polished and lapped to each other. This excludes seepage of fu between them.

Provided on body 5 side is union "h" for connection of a high-pressure pipeline and a through channel.

The slotted filter incorporates outer bushing 8 and inner cylinder 12. Milled on the outer surface of cylinder 12 are forty blind grooves. Twenty inlet grooves "i" reach one butt end of the cylinder and twenty outlet grooves "j" reach the other butt end. The grooves have a depth of 0.4±0.15 mm and are arranged in turn. Diametral clearance between the cylinder and the bushing is 0.02 - 0.04 mm. The butt ends are ground and finished together. The bushing and the cylinder make a matched pair; they must be replaced in pair only.

The filter operates as follows: fuel supplied to union "h" from the fuel injection pu passes via channel "l" into circular groove "m" on the lower butt end of the injector body and therefrom into grooves "i" of the slotted filter. As these grooves are not through, fu is forced into the clearance between inner cylinder 12 and outer bushing 8 into grooves "j" which extend to the butt end contacting the spray tip, and enters circular groove "g". In t process, mechanical particles contained in fuel are retained in grooves "i" of the inner c linder.

The injector spray tip consists of body 10 and needle 9. Provided on the body butt en is circular groove "g" with three through channels "f" branching from it and connecting groove "g" with space "e" in spray tip body.

Seven atomizing nozzle holes "d" of 0.25-mm diameter are arranged equidistantly aroun the circumference in the spray tip body lower part. The locking taper of spray tip needle 9 is pressed by spring 4 through stem 6 to the seat in the body, cutting off access of fuel t the nozzle holes. The spray tip needle has two circular grooves "b" which improve sealing c the needle in the body and ensure lubrication of the friction surfaces.

The pressure, at which fuel injection starts, is adjusted by tightening of spring 4 with the help of nut 1 locked with locknut 3. Washer 2 is placed between the nut and the spring.

The spray tip operates as follows. Fuel that has passed the injector slotted filter is delivered from groove "g" on upper butt end of spray tip body 10 via three channels "f" into space "e" and presses on the needle upper taper. When the pressure in this space built up by the fuel injection pump section reaches 250 kgf/cm^2 the needle overcomes the force of spring 4 and sharply rises for 0.4-0.5 mm and fuel is injected through nozzle holes "d" into the combustion chamber.

When fuel injection is over, pressure in space "e" of the spray tip drops sharply and the needle quickly returns to its seat. Thus, the fuel delivery is cut off without dripping of fuel.

6.3.11. Automatic Fuel Injection Advance Angle Setting Coupling

General

The coupling (Fig. 161) is intended for timing of fuel injection depending on the engine speed. Besides, the coupling transmits a torque from the engine accessory drive to the fuel injection pump camshaft.

Design of Coupling

The coupling consists of housing 18, a servomechanism of follow-up action and a centrifugal rate meter.

The coupling is mounted in a boring of the boss of cylinder block-and-crankcase unit 4.

The coupling is connected with the fuel injection pump camshaft through helical involute splines, provided on servopiston 12 and on the end of camshaft 15.

Coupling housing 18 is connected by four fitted bolts with rate meter body 10.

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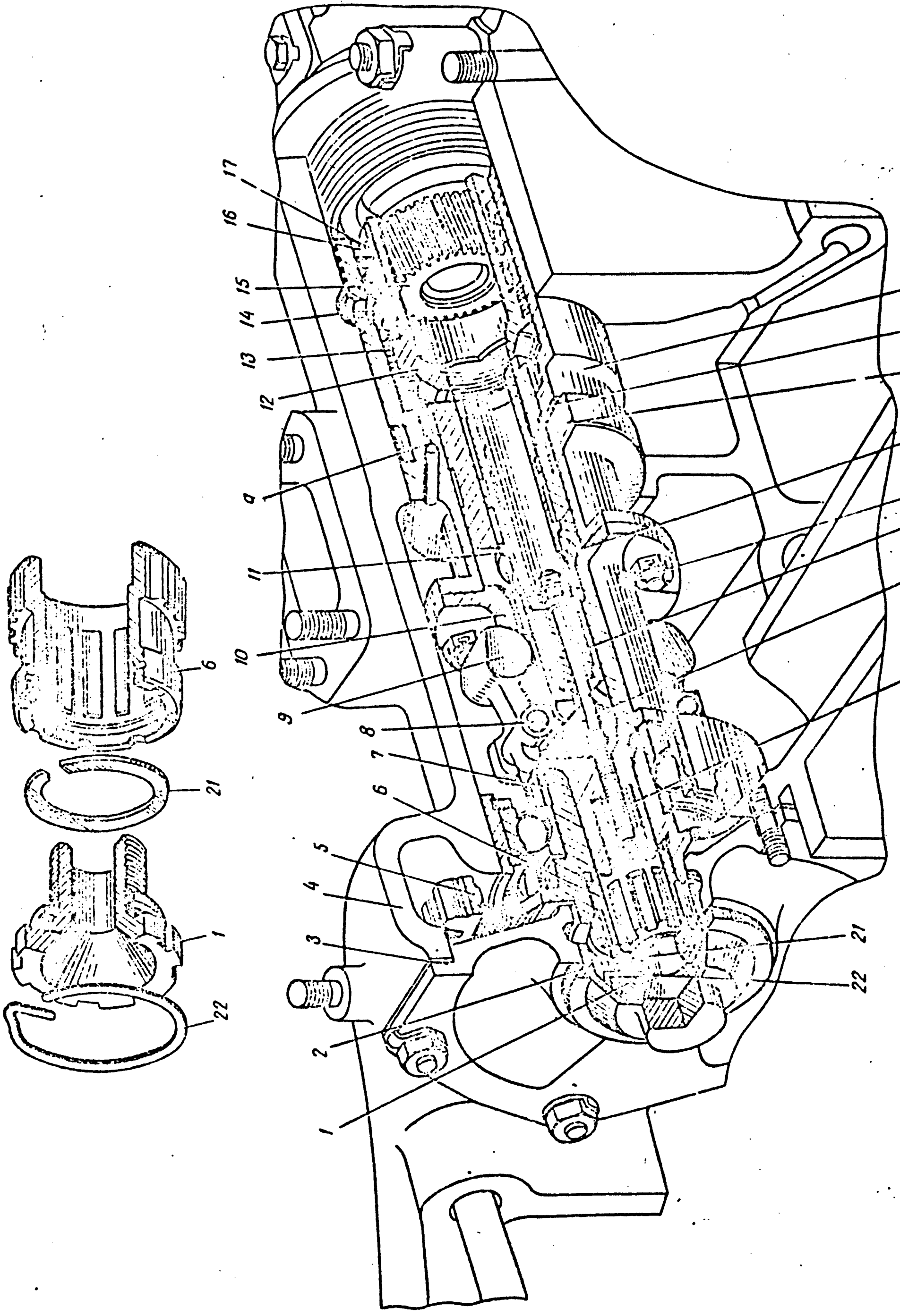
17
16
15
14
13
12
a
11
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9
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7
6
5
4
3
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b
c
18
d
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23
19
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A
21
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22

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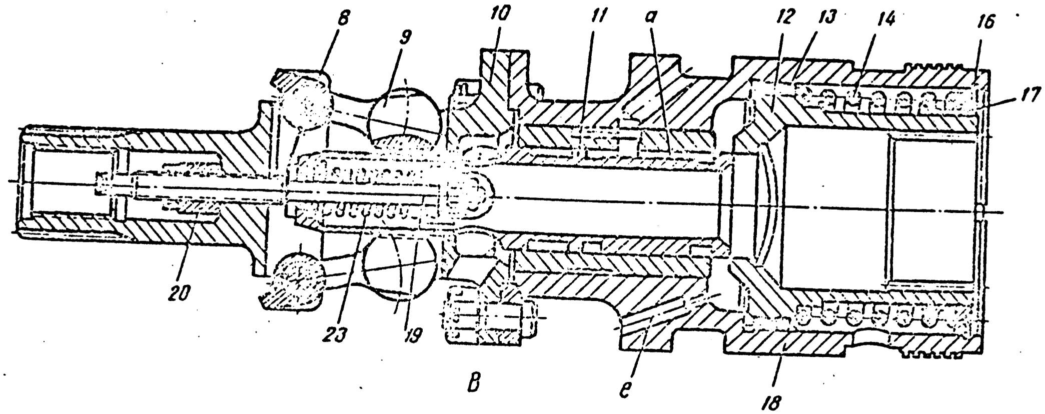


FIG.161. FUEL INJECTION ADVANCE ANGLE SETTING COUPLING

A - coupling general view; B - coupling sectional view

1, 20 - nuts; 2 - cover; 3 - flange; 4 -cylinder block-and-crankcase unit; 5 - fuel injection pump drive gear; 6 . adjusting bushing; 7 - ring; 8 - weight axle; 9 - rate meter weight; 10 - rate meter body; 11 - slide valve; 12 - servopiston; 13 - packing ring; 14 - servopiston spring; 15 - fuel injection pump camshaft; 16, 21 - lock rings; 17 - bushing; 18 - coupling housing; 19 - slide valve axle; 22 - lock ring; 23 - slide valve spring; a - by-pass channel; b - circular groove; c - oil supply hole; d, e - oil drain holes

[redacted]

Fitted in the housing of the coupling is servopiston 12, the hexagonal end of which is inserted into hexagonal hole of the housing.

The coupling housing and servopiston cylindrical surfaces are packed by means of four split cast iron rings 13. Placed in each groove of the servopiston are two rings 13.

The servopiston end boring accommodates slide valve 11, that houses axle 19 with spring 23, a bushing and a ball bearing fitted over the axle. The axle other end is screwed into rate meter body 10 and secured by nut 20. Fitted over the servodrive is return spring 14, one end of which thrusts against the piston collar and the other against the collar of bushing 17. Bushing 17 is retained from axial displacement with lock ring 16.

A through square slot with fitted-in axles carrying two weights 9 is provided on rate meter body 10.

Weight axles 8 are fitted in the body eyes. The lugs of the weights are constantly pressed to the outer end face of slide valve 11.

The rate meter body end is connected with drive gear 5 through adjusting bushing 6.

Nut 1 is screwed into the body end threaded portion. Lock ring 21 connects the adjusting bushing with the nut. The nut is locked against unscrewing with lock ring 22.

The adjusting bushing is used to set the fuel injection advance angle. The fuel injection advance angle setting mechanism is closed from the flywheel side with cover 2 screwed into flange 3.

Operation of Coupling

As the engine runs, rate meter weights 9 under the action of centrifugal forces try to break up to a greater radius of rotation and to displace the slide valve by their lugs towards the fuel injection pump, but slide valve spring 23 offers its resistance. The spring force exceeds the centrifugal force of the weights at a crankshaft speed up to 1200 rpm; therefore, when the engine runs at a low speed, servopiston 12 is displaced by spring 14 to the extreme leftward position and the coupling operates as a rigid unit.

As the engine speed exceeds 1200 rpm, the centrifugal force of the weights grows and their lugs, overcoming the spring force, move slide valve 11 and compress its spring 23 until the forces of the spring and centrifugal force of the weights applied to the slide valve get balanced (Fig. 162).

As the slide valve moves, it opens access to oil from main oil channel "J" through grooves with holes on the housing of the coupling and servopiston and further through flats "g" on the slide valve into space "f" above the servopiston. Under the action of oil pressure the servopiston overcomes the resistance of return spring 14 and moves towards the fuel injection pump. The servopiston will keep moving until the edges of the servopiston holes close oil ingress to the space above the piston (Fig. 162B).

Axial displacement of the servopiston brings about turning of the fuel injection pump camshaft relative to the engine crankshaft, as they are coupled by means of the helical splines and the fuel injection advance angle is increased.

After stopping of oil ingress in the above-piston space the pressure in the space drops and the servopiston moves back under the action of the return spring and again opens ingress of oil. Under the oil pressure the servopiston again moves towards the fuel injection pump. Thus, the servopiston is always vibrating about the sustained position of the slide valve.

As the engine speed is reduced, the centrifugal force is decreased and the weights come closer to each other, thereby allowing the slide valve to move to the left under the spring action (Fig. 162C).

The outer follow-up edge of the slide valve opens drainage of oil, the servopiston moves to the left under the action of the spring, and turns the fuel injection pump camshaft towards reduction of the fuel injection advance angle.

[redacted]

6.3.12. Fuel Feed Control Linkage

Fuel supply to the engine cylinders is controlled by the driver by means of a mechanical linkage with pedal and manual control.

The pedal control linkage comprises pedal 3 (Fig. 163), rods 10, 12, 19, 20 and 25, pedal bridge pipe 23 with two levers, an engine shutdown mechanism, vertical shaft 6 and post 8 with double-arm lever 9.

The manual control linkage consists of locking device body 37, adjusting bolt 43, spring 42, ball 35, screw 36, control handle 5 and rod 4.

Screw 36 is retained from spontaneous unscrewing by ball 35 pressed with spring 42.

The engine shutdown mechanism is intended for stopping the engine when the ABC protection system operates by means of disconnecting the fuel feed control linkage. The mechanism consists of base 31, electromagnet (ЭЛС-3) 16, mechanism rod 26 joined with the electromagnet core rod, the rod spring and two levers 32 and 33. Lever 33 is freely fitted on pin 34 pressed in the upper end of lever 32 and is locked by the end of rod 26, which enters in the seat made in lever 33. The lower end of lever 32 is connected by a system of rods 4 with pedal 3 and lever 33 is connected with the control linkage vertical shaft 6.

When the end of rod 26 is in the seat of lever 33, the levers turn as one unit and if it goes out of the seat (when the electromagnet operates) they become disconnected and motion is not transmitted through them.

Operation of the control linkage is as follows: when pedal 3 is depressed, rod 25 is displaced and turns pedal bridge pipe 23 through lever 24. Turned together with the pipe is a lever that turns through rod 20 lever 32 fitted on the rod of the engine shutdown mechanism. Lever 33 fitted on the end of rod 26 and connected with lever 32 by pin 34 turns together with lever 32 and pulls rod 19 whose end is hinge-joined to the lower lever of vertical shaft 6. While turning, vertical shaft 6 turns double-arm lever 9 through a rod. The double-arm lever turns through rod 10 fuel injection pump control lever 43 (Fig. 156) and displaces control racks 19 changing the fuel delivery. In this case the manual control linkage remains static, as pin 44 (Fig. 163) of double-arm lever 24 moves freely in slot "a" of rod 4 lower eye. The pedal returns to the initial position under the action of spring 21.

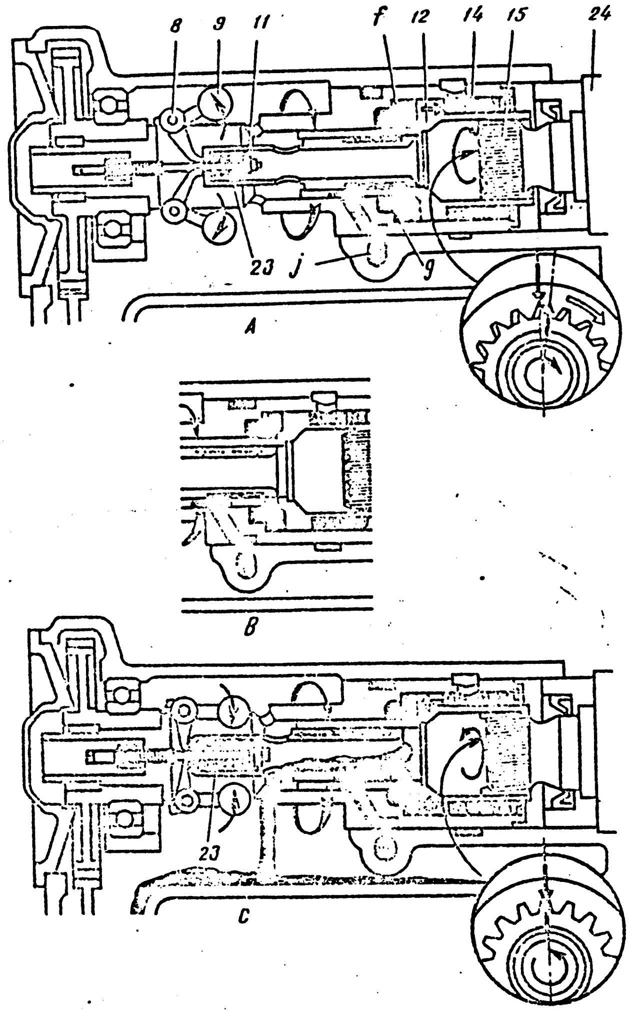


FIG. 162. FUEL INJECTION ADVANCE ANGLE SETTING COUPLING OPERATION DIAGRAM (DESIGNATIONS ARE IDENTICAL TO THOSE IN FIG. 161)

24 - fuel injection pump; f - space above piston; g - flats on slide valve; j - main channel; A - position of coupling elements at increase of engine speed; B - position of coupling elements at stable speed; C - position of elements when speed is decreased

[redacted]

The manual drive is used to set the minimum stable sp also during long operation at the set speed (mainly during warming-up of the engine).

As handle 5 is turned counterclockwise screw 36 is also turned and its thread riding on ball 35 is screwed out of body 37 secured on engine compartment bulkhead 7.

The screw pulls rod 4 that turns double-arm lever 24. Further the motion is transmitt in the same way as from the pedal control.

As the engine shutdown mechanism operates, rod 26 mounting levers 32 and 33 is drawn into the electromagnet body and goes out of the hole of lever 33. Therefore, when fuel feed pedal 3 is depressed the linkage remains inoperative as lever 33 has no support and transm no effort to rod 20, thus delivery of fuel to the engine stops and the latter is shut down.

To restore the fuel feed control linkage turn manual feed control handle 5 clockwise as far as it will go and then release pedal 3; as a result, the disconnected levers 32 and of the engine shutdown mechanism will reconnect under the action of spring 28, which will introduce the end of rod 26 in the hole of lever 33.

Position of pedal 3 depressed until it rests against adjusting bolt 2 corresponds to maximum fuel delivery. See that a clearance of 0.15 - 0.3 mm is provided between lever 13 and limit stop 14. With pedal 3 completely released, lever 13 must rest against limit sto (with manual feed control handle 5 screwed in completely). Herewith, the fuel injection p control racks are in zero feed position.

6.3.13. Operation of Fuel Feed System

Before starting the engine, the driver switches on fuel feed pump 2 (Fig. 164) by tu ing the appropriate switch on the central panel, and fuel from the tanks is supplied to cock 4 and then through coarse fuel filter 5, fuel feed pump 7, fine fuel filter it is de vered to the fuel injection pump and returns into the tank. In the process the air that h penetrated into the system is bled from the system.

During the engine operation a portion of the fuel from the fuel injection pump is de vered via high-pressure pipes to the injectors and into the combustion chambers and the r mainder of the fuel returns into the tank.

The fuel feed system branches out to the preheating system through the preheater fue cock and to the smoke-generating equipment.

To safeguard the tanks from rarefaction as the fuel gets consumed, the tanks are con nected with the atmosphere through drain valve 17 (Fig. 148).

6.3.14. Care of Fuel Feed System

General

Care of the fuel feed system consists in:

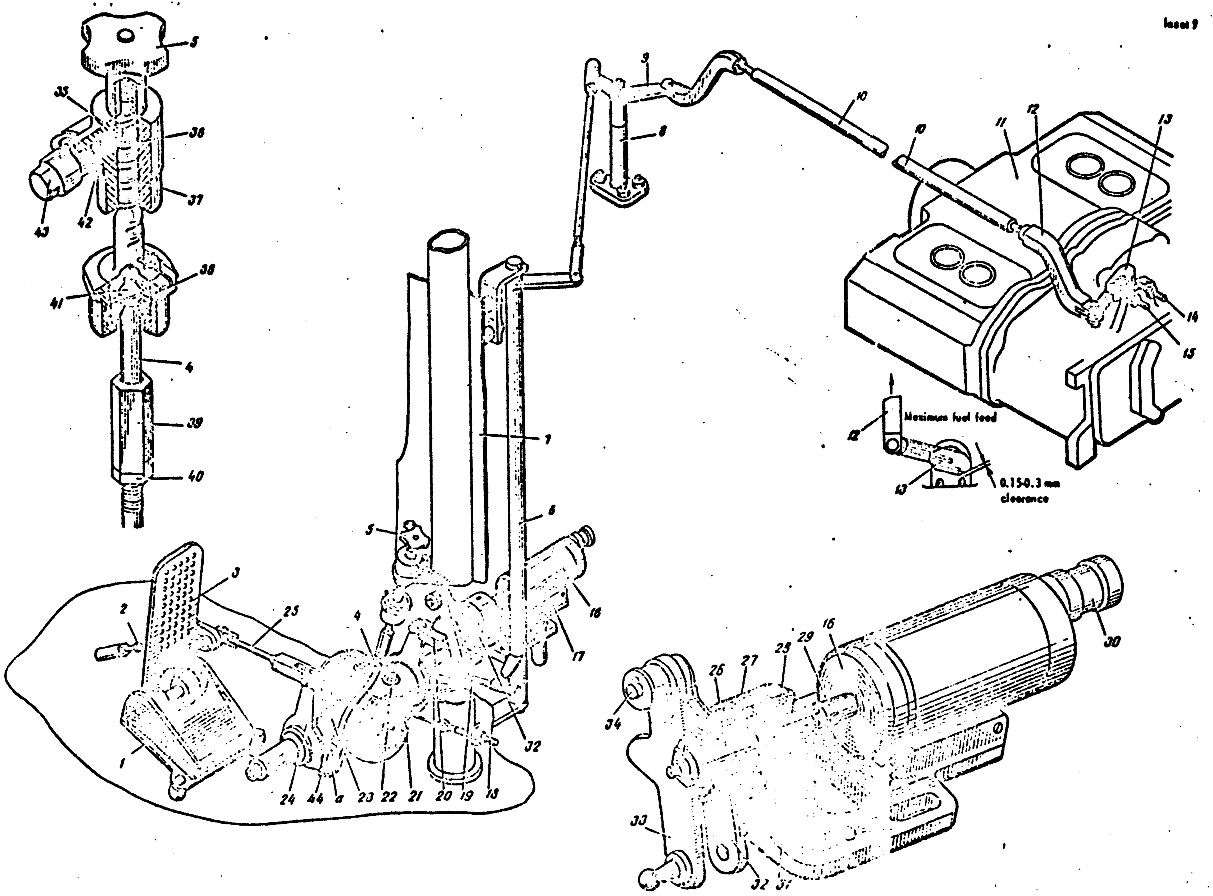
- regular checking and refilling of fuel;
- checking the units for proper fastening, the pipelines and their connections for c dition and leakage;
- regularly washing the coarse and fine fuel filters;
- checking the fuel feed control linkage for proper adjustment;
- draining sediment from the fuel tanks;
- cleaning the fuel feed system assemblies and units of dust and dirt.

Washing of Fine Fuel Filter

Washing of the filter (Fig. 155) is performed after 500 h of the engine operation. wash the filter, proceed as follows:

(a) close fuel cock 50 (Fig. 6) by setting the handle to position "3" (closed);
(b) elevate the gun;

[redacted]


Inset 9
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43
42
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11
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14
15
Maximum fuel feed
12
13
0.15-0.3 mm clearance
7
6
5
3
2
25
4
16
17
1
24
44
a
23
22
21
20
19
18
32
16
29
28
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26
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34
33
32
31

FIG.163. FUEL FEED CONTROL LINKAGE

1-heel rest; 2 - adjusting bolt; 3 - fuel feed pedal; 4 - manual control linkage rod; 5 - manual fuel feed control handle (knob); 6 - engine vertical shaft; 7 - engine compartment bulkhead; 8 - post with lever; 9 - double-arm lever; 10, 19, 20 - rods; 11 - fuel injection pump; 12 - rod to fuel injection pump lever; 13 - fuel injection pump control lever; 14 - maximum fuel feed limit stop; 15 - zero fuel feed limit stop; 16 - electromagnet (tractive relay); 17 - electromagnet support attaching bolt; 18 - spring adjusting screw; 21 - return spring; 22 - lubricating hole plug; 23 - pedal bridge pin; 24 - lever; 25 - drive rod; 26 - engine shutdown mechanism rod; 27 - bushing; 28 - spring of engine shutdown mechanism; 29 - electromagnet core rod; 30 - receptacle of plug connector; 31 - electromagnet base; 32 - drive lever; 33 - driven lever; 34 - levers connecting pin; 35 - locking device ball; 36 - screw; 37 - locking device body; 38 - nut; 39 - turnbuckle of manual control linkage rod; 40 - locknut; 41 - insert; 42 - spring; 43 - adjusting bolt; 44 - pin; a - slot

[redacted]

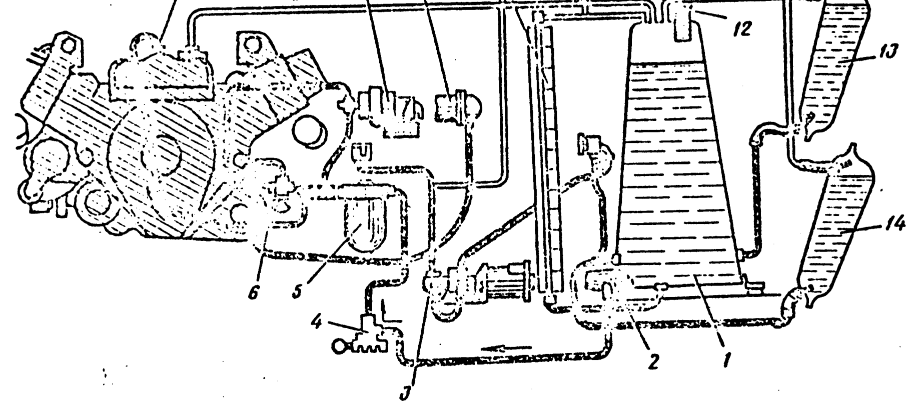

FIG. 164. DIAGRAM OF ENGINE FUEL FEED SYSTEM

1 - fuel tank; 2 - fuel feed pump БЦН; 3 - smoke generating equipment pump; 4 - fuel cock; 5 - coarse fuel filter; 6 - preheater fuel cock; 7 - engine fuel feed pump; 8 - preheater pump unit; 9 - preheater; 10 - fuel level indicator; 11 - pipeline for air release from smoke-generating equipment pump; 12 - tank filler neck; 13, 14 - rear tanks

(c) remove the engine hatch cover attaching bolts and open the cover;

(d) unscrew coupling bolt 3 (Fig. 155) from the fuel filter body;

(e) remove filter cover 2, an under-head gasket of bolt 3, spring 4, the oil seal plate complete with oil seal 6, clean them from outside of dirt and wash with the diesel fuel in the assembled state;

(f) take the filtering element assembly out of the filter body and wash it with diesel fuel;

(g) unscrew nut 7, remove pressure plate 8 and disassemble the filtering element;

(h) wash the filter metal gauze and silk gauze as well as inlet and outlet spacers with diesel fuel;

(i) using a syringe remove fuel from the filter body and wipe its inner surface with a clean cloth;

(j) carefully wash each filtering plate and squeeze them out;

(k) slip over the filter metal gauze and silk gauze in turn the following: an inlet spacer, a filtering plate, an outlet spacer, a filtering plate, an inlet spacer and follow this sequence of installation up to the end. The felt plates should be, if possible, installed in the position occupied by them before disassembly so that the side of the plate facing the inlet spacer is again positioned in the same way. While assembling see that the lugs located along the outer diameter of the inlet and outlet spacers are arranged in one and the same plane. If after washing and assembly the thickness of the filtering set is decreased, add one felt plate and one spacer in compliance with the sequence of assembly;

(l) slip the pressure plate over;

(m) screw on and tighten nut 7 and install the filtering element into the filter body;

(n) install the coupling bolt with the parts attached to it into the filter body and tighten it up until stop;

(o) open the fuel cock and switch on the battery switch;

(p) turn on fuel feed pump BЦH switch on the central panel and check for leakage of fuel from the filter;

(q) turn pump BЦH switch and battery switch off and close the fuel cock;

(r) close the hatch cover above the engine and secure it;

(s) depress the gun.

[redacted]

Washing of Coarse Fuel Filter

Wash the filter after every 2400-2500 km of run as follows:

(a) close fuel cock 50 (Fig. 6) by setting the handle to position "3" (closed);

(b) traverse the turret to the right through 120°;

(c) remove the cover from access hole 9 (Fig. 15) in the engine compartment bulkhead;

(d) unscrew coupling nut 8 (Fig. 153) on the filter cover and, supporting the filter body from below remove it from the vehicle and place in a bucket;

(e) remove from the body filtering element 3, the gland, thrust washer, pressure spring and remove packing gasket from the filtering element;

(f) wash with clean diesel fuel the filtering element, filter body, gland, thrust washer, and pressure spring;

(g) assemble the filter;

(h) clamp the assembled filter to the cover, screw on and tighten up nut 8;

(i) open the fuel cock, having turned the handle to position "0" (opened);

(j) turn the battery switch on;

(k) switch on fuel feed pump БЦН and check for leakage from under the filter cover;

(l) switch off fuel feed pump БЦН and close the fuel cock;

(m) install in position the access hole cover and secure it.

Checking and Adjustment of Fuel Feed Control Linkage

Check and adjust the fuel feed control linkage after 4800-5000 km of run as follows:

(a) unscrew the bolts securing the above-engine hatch cover and open the cover;

(b) depress pedal 3 (Fig. 163) until it rests against the head of adjusting bolt 2 and using a feeler gauge check the clearance between fuel injection pump lever 13 and limit stop 14. The clearance must be within 0.15 - 0.3 mm. If the clearance is wrong, back the locknut on adjusting bolt 2 and set the required clearance by turning the bolt and then lock up the bolt;

(c) release the pedal and check if lever 13 thrusts against limit stop 15. If the lever does not rest on the limit stop, change the length of rod 4 by means of turnbuckle 39 to obtain correct adjustment.

Checking and Adjustment of Fuel Injection Advance Angle

Checking and adjustment are carried out when necessary, if abnormal operation of the engine caused by wrong adjustment of the fuel injection advance angle is detected and also after removing the pump for repair or replacement.

Determine first the TDC in the third left-hand cylinder, for this purpose:

(a) unscrew the bolts securing the front ribbed plate of the hull and raise it until it is retained by the lock;

(b) unscrew the bolts securing the cover of the hatch above the engine and open it;

(c) disconnect the plug connector of the louvres control switch and detach rod 17 (Fig. 180) from lever 18;

(d) remove the bolts securing the roof above the engine, close the hatch above the engine and remove the roof;

(e) remove cover 6 (Fig. 15) from the access hole on the engine compartment bulkhead;

(f) unscrew the bolts securing the casing above index 7 (Fig. 133) and remove the casing;

(g) unscrew the bolts attaching cover 29 (Fig. 8) to the engine clutch housing access hole and remove the cover;

(h) secure the device for cranking the engine on the engine clutch access hole with bolts;

(i) unscrew the nuts attaching cover 8 (Fig. 133) of the third left-hand cylinder access hatch in the cylinder head;

[redacted]

(j) set the third left-hand cylinder piston in the compression stroke by cranking the engine by the device until the cams of the third cylinder camshafts are directed upwards pressing the valve discs;

(k) disconnect the high-pressure pipeline from the injector of the third-left-hand cylinder. To this end, loosen clamping nuts 19 (Fig. 132), screw out pressure union 21 (Fig. 160) and then withdraw the tapered end of pipe 13 from its seat in the body of injector 20;

(l) unscrew the nuts securing the injector, remove the injector from the engine and mount a timing gauge instead;

(m) slowly turning the engine crankshaft in the direction of its rotation (counterclockwise, if viewed from the flywheel side), press the timing gauge and watch motion of the timing gauge pointer. At the moment when the timing gauge pointer is within 5-10 divisions before "0" on the timing gauge scale, stop the crankshaft, note the division on the timing gauge scale and put a mark on the flywheel calibrated rim opposite index 7 (Fig. 133) secured on the cylinder block-and-crankcase unit.

(n) slowly rotate the crankshaft in its direction of rotation until the timing gauge pointer passes the zero division and, on its way back, occupies the position opposite the previously noted division on the scale. Put the second mark on the calibrated rim opposite index 7;

(o) half the arc on the flywheel calibrated rim and put the middle mark. When the middle mark is aligned with the index,the piston of the third left-hand cylinder is in TDC;

(p) check the determined TDC two-three times by repeating the three previous operations;

(q) remove the timing gauge from the engine, install the injector and secure it with the nuts;

(r) connect the high-pressure pipe to the injector, screw in the union and tighten the nuts;

(s) install the cover in position and secure it.

After determination of the TDC start checking the fuel injection advance angle as follows:

(a) detach the high-pressure pipeline of the third left-hand cylinder from delivery valve 44 (Fig. 156) of the fuel injection pump;

(b) mount the device for checking of fuel injection advance angle on the delivery valve in the following sequence:

- unscrew partially stop 5 (Fig. 165) from device body 4 to prevent bending the stop end during mounting;
- screw device body 4 on the delivery valve thread, having placed a sealing ring between them;
- screw union 3 on body 4 having placed a sealing ring between them;
- secure pipe 1 to union 3 by union nut 2, having placed a gasket between them;

(c) turn the engine crankshaft opposite its direction of rotation and set the left-hand cylinder piston to position within 40 - 60° before TDC (by the scale on the flywheel);

(d) turn on the battery switch;

(e) depress the fuel feed pedal until stop;

(f) turn on switch БЦН on the central panel; fuel will start dropping from pipe 1 of the device;

(g) slowly turning the crankshaft in its direction of rotation, watch the fuel dropping from the device pipe. Stop the crankshaft when fuel ceases dropping. This position corresponds to the beginning of fuel injection to the third left-hand cylinder. Count the quantity of divisions on the flywheel calibrated rim from index 7 (Fig. 133) up to the mark corresponding to TDC of the third left-hand cylinder;

(h) repeat determination of the fuel injection advance angle two-three times;

[redacted]

(i) release the fuel feed pedal, turn off fuel feed pump БЦН switch and battery switch;

(j) compare the obtained result with the entry in the engine Certificate and adjust in case of discrepancy.

Adjust the fuel injection advance angle in the following sequence:

(a) rotate the engine crankshaft 40-60° opposite its direction of rotation and then, slowly rotating it in the direction of rotation, set the piston of the third left-hand cylinder to the position corresponding to the entry in the Service Log of this engine;

(b) remove the device for cranking the engine;

(c) unlock and unscrew cover 9 (Fig. 133) of the fuel injection advance angle setting coupling;

(d) remove lock ring 22 (Fig. 161), screw out nut 1 (the nut has left-hand thread) of adjusting splined bushing 6 and remove the bushing;

(e) depress the fuel feed pedal all the way;

(f) turn the battery switch and fuel feed pump БЦН switch on;

(g) slowly rotate the fuel injection advance angle setting coupling clockwise (if viewed from the flywheel side) till the moment fuel stops dropping from the pipe of the device for determination of fuel injection advance angle;

(h) engage the adjusting splined bushing 6 with the housing of fuel injection advance angle setting coupling and fuel injection pump drive gear 5 and tighten up nut 1 of the bushing;

(i) check the fuel injection advance angle for correct adjustment, as indicated above;

(j) turn the fuel feed pump БЦН and battery switches off;

(k) install lock ring 22, screw up the coupling cover and cotter it with wire;

(l) remove the device for determination of fuel injection advance angle from the delivery valve;

(m) remove the device for cranking the engine;

(n) mount the casing and access hole cover of the engine clutch in position and secure them by bolts;

(o) install in position the access hole cover on the engine compartment bulkhead;

(p) reinstall the hull front ribbed plate and the roof plate above the engine.

Sequence of Filling Fuel into Fuel Feed System

To fill the fuel into system, proceed as follows:

(a) uncotter the plugs of filler necks, clean them of dust and dirt, and remove;

(b) withdraw the gauze filters from the filler necks;

(c) insert the filling truck dispensing gun into the filler neck and fill the main fuel tank and door tanks with fuel. The fuel level must reach the lower edges of the filler necks;

(d) install the gauze filters into the filler necks; screw in the filler neck plugs and cotter them. Remove the filters from the filler necks only in case the filling means are furnished with their own filters. In case mechanized filling means are not available, fill fuel from a bucket using a filling funnel with a filter through a silk cloth.

Drainage of Sediment from Fuel Tanks

To drain sediment, proceed as follows:

(a) unscrew armour plug 4 (Fig. 13) from the vehicle bottom. Uncotter and remove the drain plug from the fuel tank;

(b) screw in the wrench with fuel and oil draining hose and drain 5-6 l of sediment int the bucket;

(c) screw out the wrench with fuel and oil draining hose;

(d) screw in the drain plug and cotter it. Screw the armour plug into the vehicle botto

[redacted]

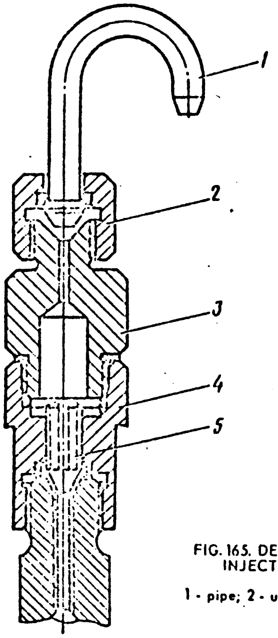

FIG. 165. DEVICE FOR CHECKING OF FUEL INJECTION ADVANCE ANGLE

1 - pipe; 2 - union nut; 3 - union; 4 - body; 5 - stop

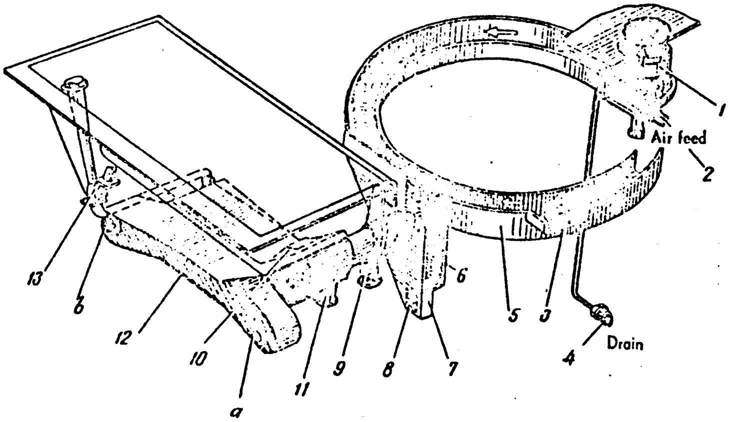

FIG. 166. ENGINE AIR SUPPLY SYSTEM

1 - air intake pipe; 2 - air supply lines from pneumatic system; 3 - sir intake branch pipe to filter-ventilating unit; 4 - water drain valve from air intake pipe pan; 5 - annular air duct; 6 - pocket cover; 7 - air duct pocket; 8 - valve to drain water from air duct pocket; 9 - air intake branch pipe to compressor; 10 - hole of winter air intake channel to air cleaner; 11 - air intake branch pipe of generator; 12 - air cleaner; 13 - dust ejector; a - air outlet to L.H. cylinder bank; b - air outlet to R.H. cylinder bank

[redacted]

Follow the same sequence of operations while draining fuel from the tanks,
the filler neck plugs are open.

6.4. ENGINE AIR SUPPLY SYSTEM

6.4.1. Purpose and Components

The engine air supply system (Fig. 166) is intended to clean the air, entering the engine cylinders, of dust.

The system consists of air intake pipe 1, annular air duct 5, air cleaner 12 with dust ejector 13 and two intake manifolds secured to the engine cylinder heads.

6.4.2. Design

The air intake pipe (Fig. 167) is a telescopic type. It is located on the roof between the turret and upper hatches of the troop compartment. Installed inside the pipe along its axis is pneumatic cylinder 1 used for extending the pipe upwards when the vehicle is afloat. Attached to pneumatic cylinder rod, is cowl 16, protecting the pipe against atmospheric precipitation and reducing the effect of blast wave.

The air intake pipe is built into annular air duct 23. Pneumatic cylinder 1 consists of a cylindrical body housing rod 9 with piston 32. Provided in the body walls at the bottom an top are unions 34 and 36, to which compressed air from the system is supplied. The piston together with rod 9, cowl 16 and the air intake pipe go up or down depending on the union through which the air is delivered. For cushioning the shocks during pneumatic cylinder operation spring 17 is installed under cowl 16.

The air intake pipe pneumatic control is combined with the splash panel control.

The air cleaner (Fig. 168) is a cassetteless cyclone-type device with automatic ejectio of dust from a dust collector. It is installed in the engine compartment under the ejector casing to which it is secured by bolts. The air cleaner is a welded box-like structure with a vortex tube device welded in it. The vortex tube device consists of 39 identical vortex tubes 8. A vortex tube consists of cone-shaped body 17, air inlet port 9 that is essentiall a tube having an elliptical cross section welded tangentially relative to the body, and cent ral branch pipe 18 welded into the vortex tube bottom.

The vortex tubes are secured in two longitudinal partitions A of the air cleaner body, which divide it into section of dust collector 7, the vortex tube device middle section and the clean air section.

Welded to the air cleaner body wall on the side of dust collector 7 is branch pipe 10 serving to communicate the body with the annular duct through a durite hose and from the c air collector side are two branch pipes 14 connected by hoses with the intake manifolds of the engine. Branch pipe 12 supplying the air for cooling of the generator is welded from b low. The air supplied to the generator is cleaned by means of inertia grate 13 installed i side the ejector casing.

Fitted at dust collector 7 outlet is valve 21 preventing ingress of water into the a cleaner through the dust suction pipeline when the vehicle is afloat. This valve is insta led in valve box 6 at the outlet of pipeline 4. The plate valve is installed on an axle having a lever at the end. The lever is connected with pneumatic cylinder rod 20 by a pin In the initial position the valve is kept open by spiral spring 19 fitted over the valve axle. The valve control is combined with the control of the air intake pipe and splash pa

Dust is removed from the dust collector via ejector 2, connected to which is pipe 3 plying the exhaust gases from the ejector casing. The lower end of ejector 2 is expanded accommodate the nozzle end of pipe 3. The exhaust gas flow passing from the pipe nozzle sucks the air and along with it, dust from dust collector 7.

Mounted in the ejector bottom is winter air intake shutter "D". It closes the hole municating the ejector space in front of the radiators with the air cleaner housing. The

[redacted]

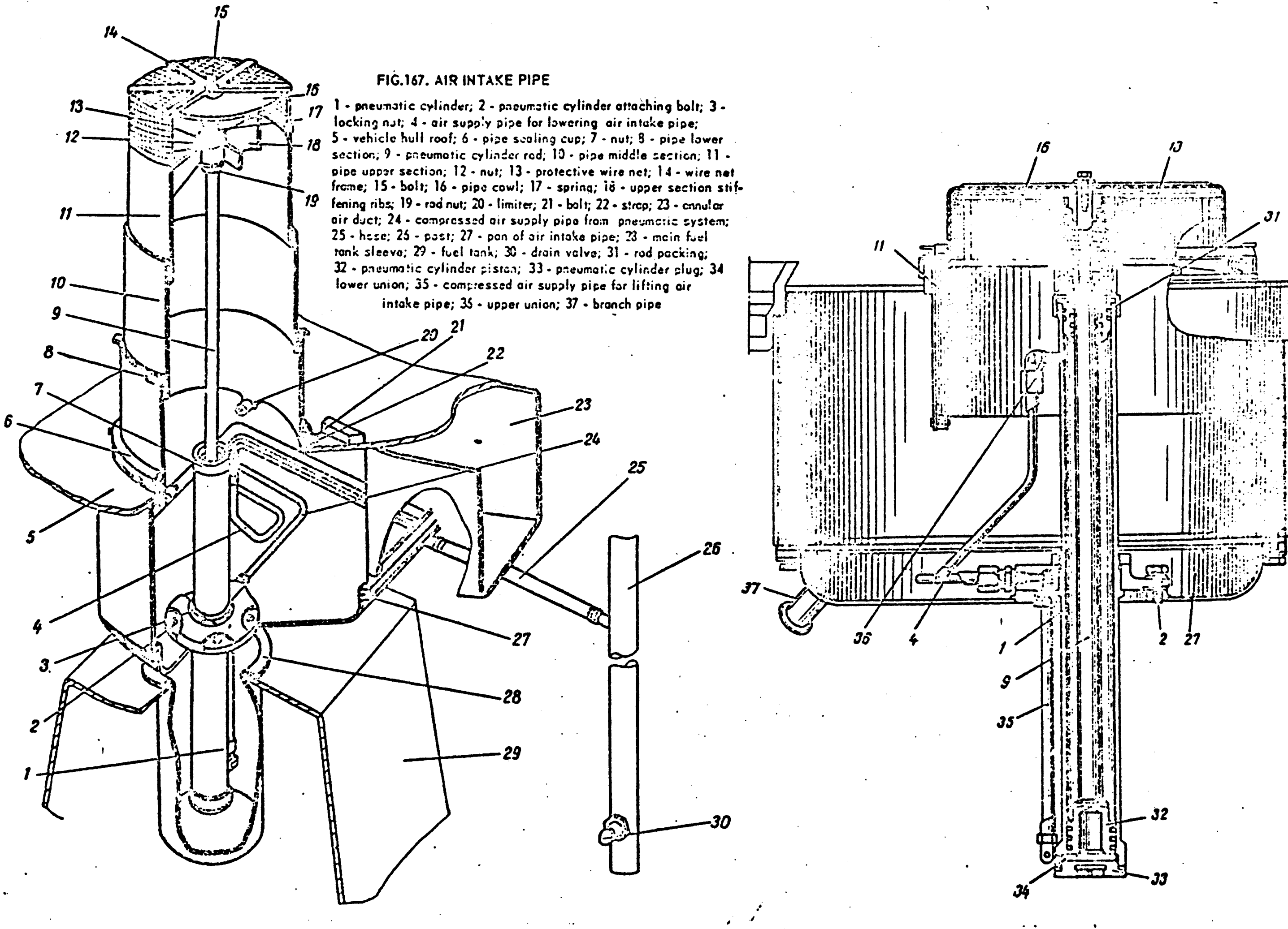
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FIG.167. AIR INTAKE PIPE

1 - pneumatic cylinder; 2 - pneumatic cylinder attaching bolt; 3 - locking nut; 4 - air supply pipe for lowering air intake pipe; 5 - vehicle hull roof; 6 - pipe sealing cup; 7 - nut; 8 - pipe lower section; 9 - pneumatic cylinder rod; 10 - pipe middle section; 11 - pipe upper section; 12 - nut; 13 - protective wire net; 14 - wire net frame; 15 - bolt; 16 - pipe cowl; 17 - spring; 18 - upper section stiffening ribs; 19 - rod nut; 20 - limiter; 21 - bolt; 22 - strap; 23 - annular air duct; 24 - compressed air supply pipe from pneumatic system; 25 - hose; 26 - post; 27 - pan of air intake pipe; 28 - main fuel tank sleeve; 29 - fuel tank; 30 - drain valve; 31 - rod packing; 32 - pneumatic cylinder piston; 33 - pneumatic cylinder plug; 34 - lower union; 35 - compressed air supply pipe for lifting air intake pipe; 36 - upper union; 37 - branch pipe

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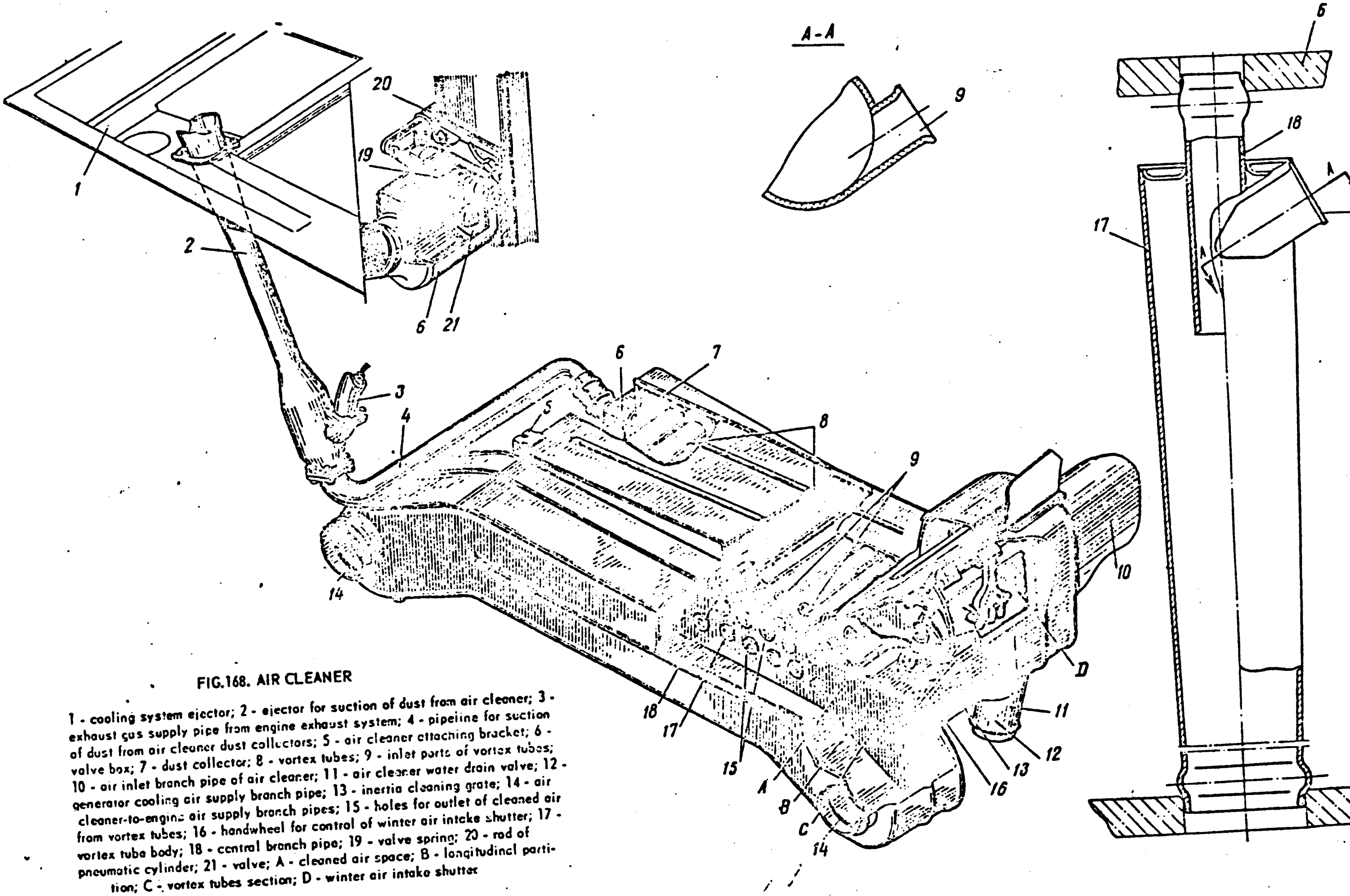


FIG.168. AIR CLEANER

1 - cooling system ejector; 2 - ejector for suction of dust from air cleaner; 3 -
exhaust gus supply pipe from engine exhaust system; 4 - pipeline for suction
of dust from air cleaner dust collectors; 5 - air cleaner attaching bracket; 6 -
valve box; 7 - dust collector; 8 - vortex tubes; 9 - inlet ports of vortex tubes;
10 - air inlet branch pipe of air cleaner; 11 - air cleaner water drain valve; 12 -
generator cooling air supply branch pipe; 13 - inertia cleaning grate; 14 - air
cleaner-to-engine air supply branch pipes; 15 - holes for outlet of cleaned air
from vortex tubes; 16 - handwheel for control of winter air intake shutter; 17 -
vortex tube body; 18 - central branch pipe; 19 - valve spring; 20 - rod of
pneumatic cylinder; 21 - valve; A - cleaned air space; B - longitudinal parti-
tion; C - vortex tubes section; D - winter air intake shutter

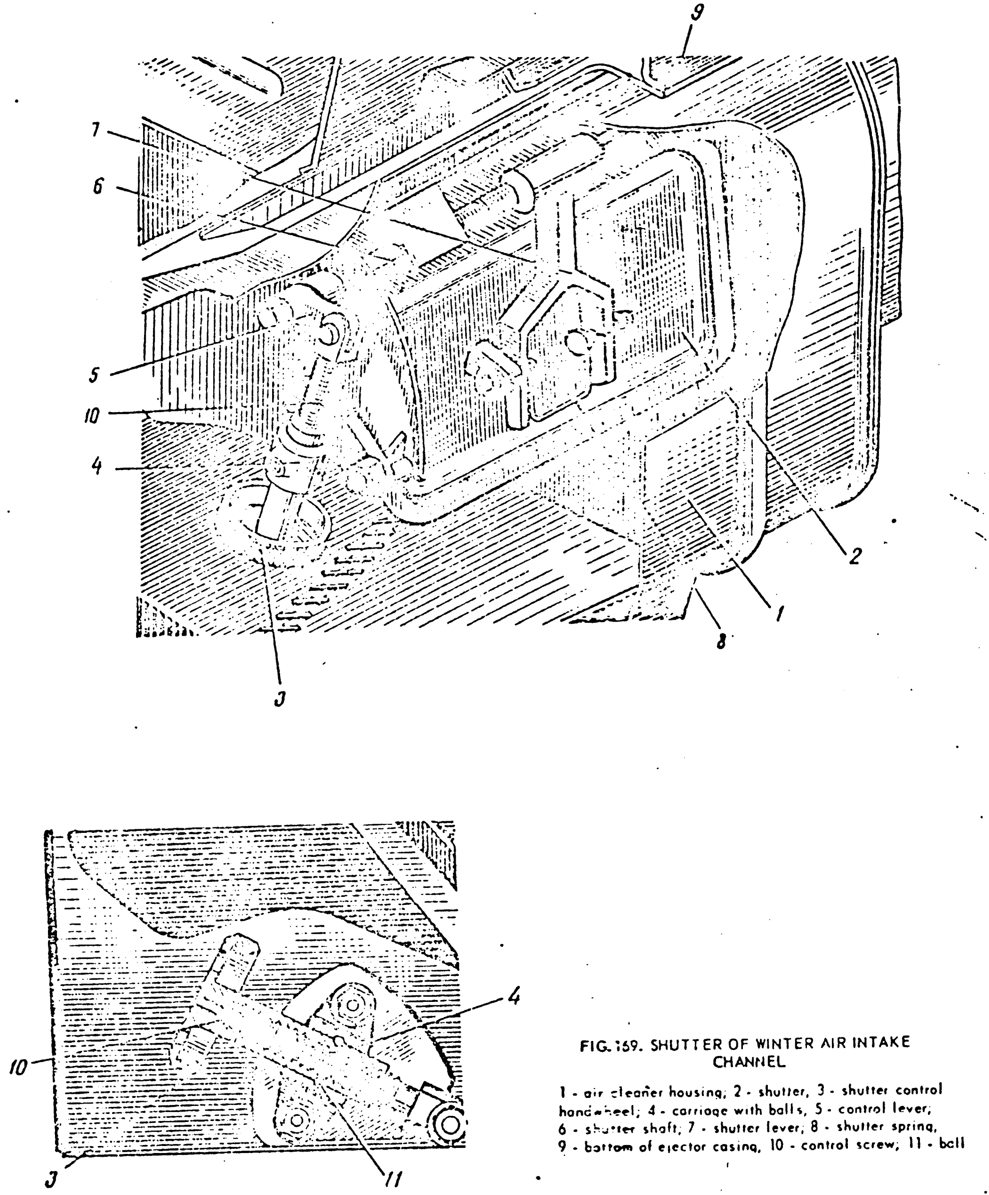


FIG. 159. SHUTTER OF WINTER AIR INTAKE CHANNEL

1 - air cleaner housing; 2 - shutter, 3 - shutter control handwheel; 4 - carriage with balls, 5 - control lever; 6 - shutter shaft; 7 - shutter lever; 8 - shutter spring, 9 - bottom of ejector casing, 10 - control screw; 11 - ball

[redacted]

shutter has two fixed positions and is controlled by means of a mechanical control linkage. The linkage consists of handwheel 3 (Fig. 169), carriage 4 with the balls, screw 10 which moves along the carriage thread, shaft 6 joined with screw 10 by lever 5 and shutter 2, secured on the shaft and pressed by spring 8.

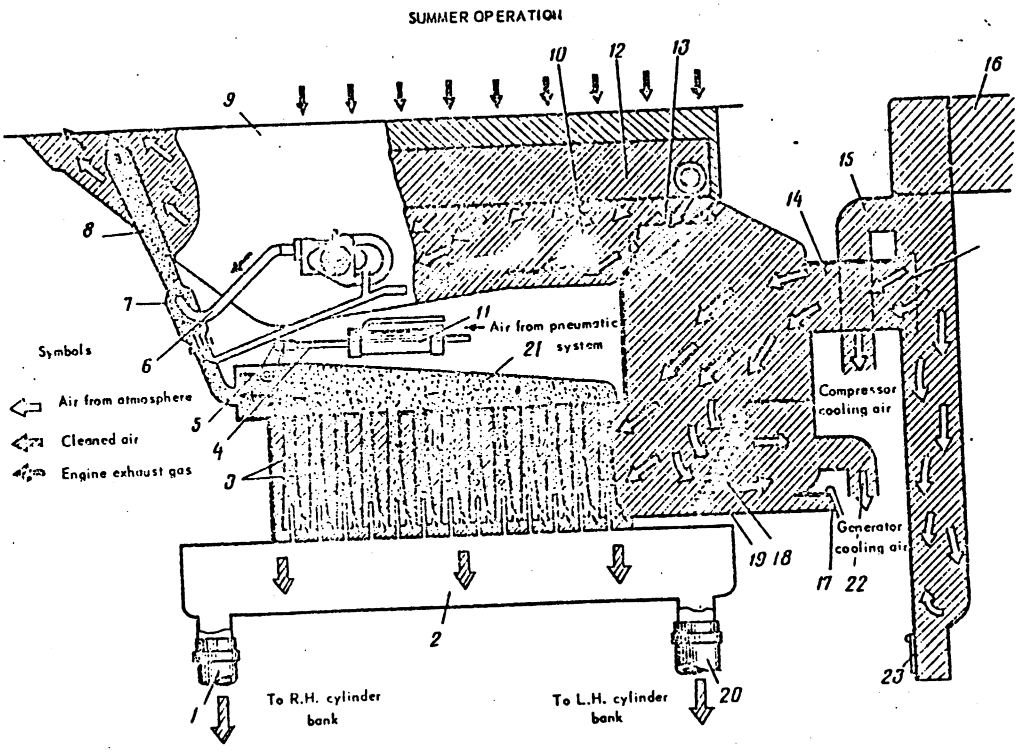
In summer time and when the vehicle is afloat, handwheel 3 must be turned in the direction indicated by arrow CLOSED (ЗАКРЫТО), and in winter - turned in the direction of arrow OPEN (ОТКРЫТО).

Mounted in the air cleaner bottom are two valves 11 (Fig. 168) for draining water from the air cleaner.

6.4.3. Operation

In summer and when the vehicle is afloat the air passes inside the air cleaner only through air intake pipe 1 (Fig. 166), wherefrom it goes into annular air duct 5 and then to pocket 7, where it gets branched into two flows.

The main flow passes through the gauze and branch pipe 14 (Fig. 170) into the air cleaner, the other goes through branch pipe 15 to cool the compressor.


SUMMER OPERATION
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Symbols
Air from atmosphere
Cleaned air
Engine exhaust gas
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4
3
Compressor cooling air
Generator cooling air
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18
17
22
2
23
1
To R.H. cylinder bank
To L.H. cylinder bank
20

FIG. 170. DIAGRAM OF AIR CLEANER OPERATION

1 - air supply branch pipe to R.H. cylinder bank; 2 - cleaned air space; 3 - vortex tubes; 4 - pneumatic cylinder rod; 5 - air cleaner water protection valve; 6 - exhaust gas supply pipe to dust ejector; 7 - nozzle, 8 - dust ejector; 9 - casing of cooling system ejector; 10 - exhaust gas release channel; 11 - pneumatic cylinder; 12 - engine cooling system radiators; 13 - shutter of air cleaner winter air intake channel; 14 - air supply branch pipe of air cleaner; 15 - compressor cooling air supply branch pipe, 16 - annular air duct; 17 - ejector water drain valve; 18 - inertia cleaning grate; 19 - access hole cover in air cleaner bottom; 20 - air supply branch pipe to L.H. cylinder bank, 21 - dust collector, 22 - generator cooling air supply branch pipe; 23 - valve to drain water from air duct pocket

[redacted]

In the air cleaner the bulk of air under the action of rarefaction in the engine cylin ders rushes through the air intake ports into vortex tubes 3.

Passing the tangentially-directed inlet tubes of the vortex tubes, the air starts spinning and under the action of centrifugal forces the particles of dust present in the air ar thrown to the walls of the vortex tubes and get into dust collector 21, wherefrom dust is sucked by ejector 8 and is thrown out in the atmosphere. Air cleaned in the vortex tubes passes into cleaned air space 2 and is eventually delivered into the intake manifolds and e gine cylinders via branch pipes 1 and 20.

A portion of air, after passing through inertia grate 18 is cleaned of dust under the action of inertia forces appearing as the air flow meets the inclined blades of the grate a is directed via branch pipe 22 to cool the generator.

In winter air is supplied into the air cleaner both from the annular air duct and thro the winter air intake hole. The winter air intake hole is closed in summer by shutter 13; d not fail to open the shutter when preparing the vehicle for operation in winter. This porti of air first passes through the radiators and gets heated, thus improving the conditions of the engine operation. Otherwise, the operation of the system in winter is similar to its operation in summer.

6.4.4. Care

Care of the air supply system consists in:

- checking the system for presence of water and draining it from the pockets of the ai cleaner air collector;
- checking the air cleaner and intake manifolds for proper connection;
- shifting the winter air intake shutter in the correct position;
- checking the air inlet pipe and annular air duct for fastening and condition;
- checking the durite hoses, clips and pipelines for condition.

6.5. LUBRICATION SYSTEM

6.5.1. General

The engine lubrication system (Fig. 171) is of a circulation combination type (engine parts being lubricated by oil forced under pressure or by splashing the oil). It is intendec for cleaning oil of mechanical admixtures, lubrication and dissipation of heat from the fric tion surfaces.

Oil is supplied under pressure to the connecting rod bearings, camshaft bearings, fuel injection advance angle setting coupling, air distributor shaft and oil pump bearings.

The oil squeezed out of the gaps in the bearings is splashed by the engine rotating parts to lubricate the mirror surfaces of the cylinders, gears, antifriction bearings, cams of the camshafts, piston pins and other friction surfaces.

The fuel injection pump is lubricated by oil delivered in its inner space and by splash ing.

The governor is lubricated with oil filled in the governor housing.

6.5.2. Design

The lubrication system incorporates oil tank 6 with oil filler tank 13 mounted on top of it, oil pump 1, oil priming pump (МЗН-3) 8, a centrifugal oil filter, oil cooler 19 and oil pipes.

The oil tank is arranged in the engine compartment, being secured to the vehicle right side with a clamping band. The tank capacity is 48 l. Mounted inside the oil tank is preheater boiler 30, which is bolted to the oil tank wall. Oil priming pump 8 is bolted to the tank front wall. Provided at the top of the tank are two filler necks; one of them is connected by a durite hose with oil filler tank 13, the other is used for connection of pipeline 20 intended for passing oil from the oil coolers into the tank. The tank bottom mounts

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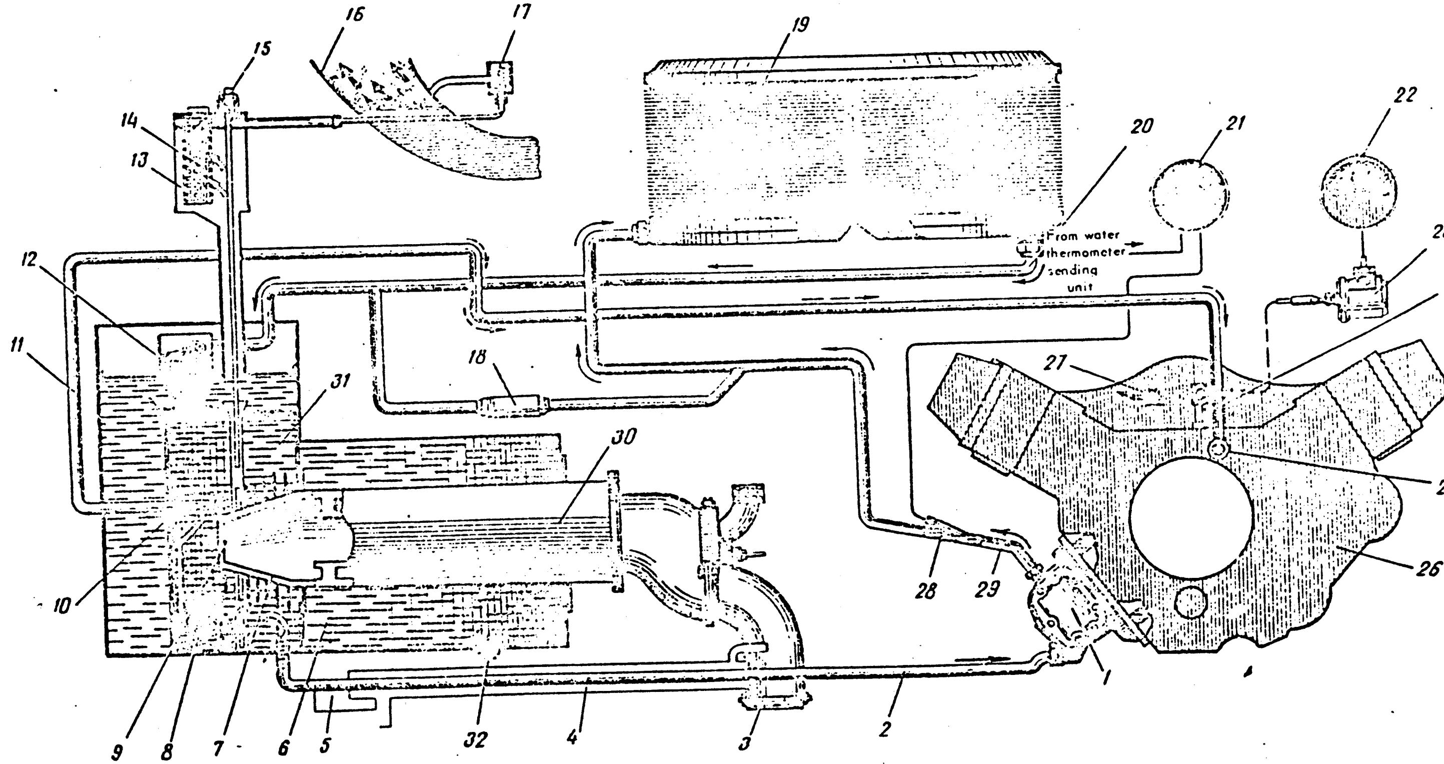
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FIG. 171. DIAGRAM OF ENGINE LUBRICATION SYSTEM

1 - oil pump; 2 - oil tank-to-pump supply pipeline; 3 - preheater exhaust gas outlet branch pipe; 4 - oil pipe warming jacket; 5 - coolant outlet pipe; 6 - oil tank; 7 - fins of preheater boiler fire cone; 8 - oil priming pump; 9 - boiler fire cone; 10 - filter; 11 - oil priming pump-to-engine pipeline; 12 - air separator; 13 - oil filler tank; 14 - gauze filter; 15 - oil level indicator(dipstick); 16 - ejector casing; 17 - water protection valve; 18 - by-pass valve; 19 - engine oil cooler; 20 - oil cooler outlet pipeline; 21 - thermometer indicator; 22 - pressure indicator; 23 - pressure pickup; 24 - pressure pickup union; 25 - non-return valve; 26 - engine; 27 - union for outlet of oil for compressor lubrication; 28 - lubrication system thermometer sending unit; 29 - pump-to-cooler pipeline; 30 - preheater boiler; 31 - oil tank circulation space; 32 - oil tank drain valve

[redacted]

is in motion. A union provided in the tank lower part serves for connection of heated pipeline 2 for delivery of oil to the engine oil pump.

Filler tank 7 (Fig. 172) has two unions; one of them is used for filling and is closed with plug 4, the other accommodates oil dipstick 8. The dipstick union nut is screwed on the union thread. The filler neck houses filtering gauze 6. Filler neck plug 4 has metal wool packing 3 intended to retain the oil when the air goes out through the drain hole. Besides, the packing prevents penetration of dust from outside together with the air.

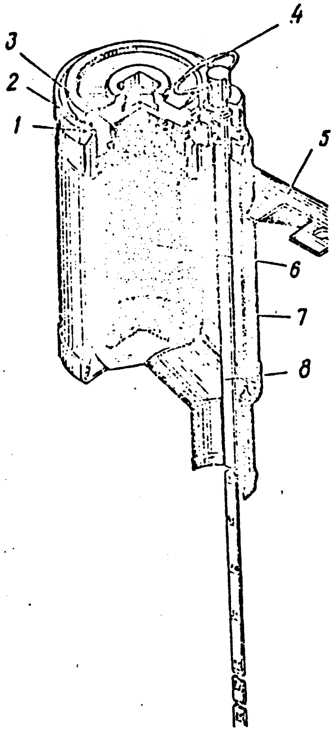

FIG.172. OIL FILLER TANK

1 - gasket; 2 - pressure ring; 3 - metal wool packing (oil separator); 4 - filler neck plug; 5 - tank attaching bracket; 6 - filtering gauze; 7 - filler tank; 8 - oil dipstick

The oil pump (Fig. 173) is of a two-section gear type. It serves for delivery of oil from the oil tank to the engine main oil gallery and for pumping oil from the cylinder block-and-crankcase unit into the tank.

The pump is secured by studs to the cylinder block-and-crankcase unit. It consists of a body, delivery and suction sections, drive gear 12, a relief valve, a non-return valve and pipelines.

The body consists of three parts coupled by bolts 2; the joints between the body parts and the covers are packed with paronite gaskets.

The delivery section consists of two spur gears 9 and 10. Oil pump drive gear 12 is fitted over the splines of drive gear 9 end. The hub of gear 10 receives resilient shaft 16, that drives suction section drive gear 1.

The suction section has three gears 1, 3 and 4, operating in pairs. One pair of the gears pumps oil from the crankcase, and the other one pumps the oil drained from the nozzles of the centrifugal filter injectors and the fuel injection advance angle setting coupling.

Both sections, have a common outlet of oil.

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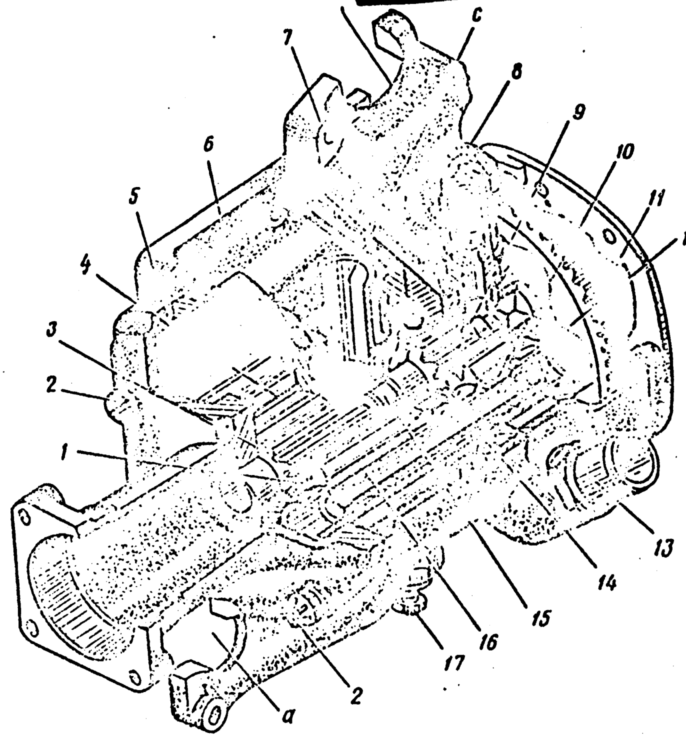

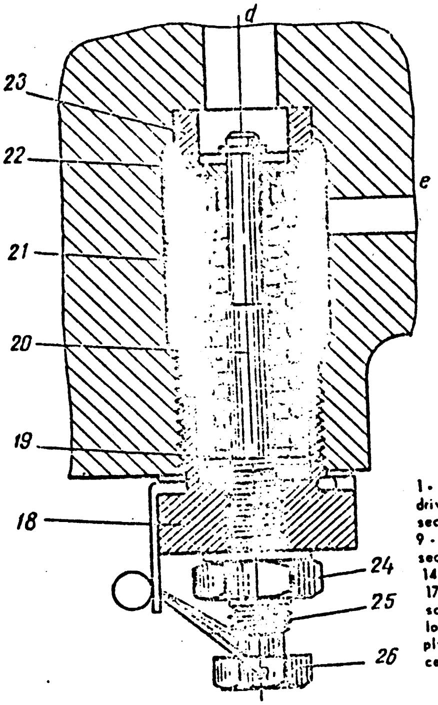

FIG.173. OIL PUMP

1 - drive gear of suction section; 2 - coupling bolt; 3, 4 - driven gears of suction section; 5 - cover-flange, 6 - suction section body; 7 - delivery section body; 8 - non-return valve; 9 - drive gear of delivery section; 10 - driven gear of delivery section; 11 - rear cover; 12 - oil pump drive gear; 13 - union; 14 - spring-loaded oil seal; 15 - stopper; 16 - resilient shaft, 17 - relief valve; 18 - relief valve body; 19 - washer; 20 - screw, 21 - valve spring; 22 - valve; 23 - valve seat; 24 - locknut; 25 - locking wire; 26 - screw head; a - hole for supply of oil from crankcase; b - hole for supply of oil from centrifugal filter; c - oil outlet channel from suction sections to oil cooler; d - axial channel; e - radial channel

[redacted]

[redacted]

The relief valve maintains the pressure in the engine oil gallery within 6 - 10.5 kgf/cm^2. It is mounted in the pump body and is located in the space communicating with the space of the pump delivery section. The valve consists of body 18, screw 20, disc valve 22, seat 23 and spring 21.

The valve body is screwed into the pump body union. Turned into the inner thread of the valve body is screw 20 carrying disc valve 22 rigidly secured at its end. Screw 20 is locked by nut 24 and wire 25, and a seal is put on it.

To adjust the valve, loosen locknut 24 and turn screw 20, using hexagon screw head 26.

Non-return valve 8 is mounted on the outlet from the delivery section. It is designed to prevent oil flow from the main oil gallery via the oil pump into the tank when the engine is inoperative. The valve consists of a body, ball and spring.

The pump operates as follows. As the engine operates, rotation is transmitted from the crankshaft through accessory drive intermediate gear 6 (Fig. 146) to gear 12 (Fig. 173) and thence to the gears of the delivery and suction sections.

Oil from the tank flows by gravity to the intake chamber of the delivery section through union 13. The rotating gear teeth drive oil to the delivery chamber where the pressure is built up causing opening of non-return valve 8 and the oil is delivered into the main oil gallery.

As the engine speed increases, the pump output becomes greater and pressure in the delivery chamber grows. When the pressure exceeds the permissible limits, the disc of relief valve 22 is pressed off its seat and a portion of oil escapes through axial channel "d" and radial channel "e" into the intake chamber of delivery section.

Simultaneously, the oil from the engine cylinder block-and-crankcase unit and the centrifugal filter nozzles is fed into the intake chambers of the suction section gears and is delivered finally into the oil cooler.

The oil filter (Fig. 174) is intended to clean oil of gum and mechanical admixtures.

The filter incorporates a coarse oil filter and a centrifugal filter connected in tandem.

The filter is mounted between the engine cylinder blocks of four studs.

The filter consists of common body 21 with two separate covers 6 and 18, a centrifugal filter, a coarse filter and a ball non-return valve.

The aluminium body is divided into two spaces. The smaller space accommodates the coarse filter consisting of hollow rod 19 turned into a threaded hole in the body bottom, filtering gauze cylinder 16 fitted over the rod and pressed from above by spring 17. The coarse filter is closed by cover 18 which is bolted to the body and packed by rubber rings 15. A lug provided at the side of this space mounts a union for supply of oil from the oil pump.

The larger space of the body houses the centrifugal filter.

The centrifugal filter consists of rod 8 fitted into the body boring and resting on the boring made in cover 6 of the filter body, a rotor and oil deflector shield 20.

The centrifugal filter rotor consists of body 7 and cover 3 coupled by two studs 13. Pressed into the rotor cover are two oil intake pipes 4 with protective nets and shield 14 pressed to the cover by the heads of studs 13.

The rotor is fitted over rod 8, rests on bearing 22 and rotates around the rod on two bronze bushings 1 and 12 pressed into the rotor cover and body.

The inner space of rotor 8 is closed from below with threaded stopper 24, and from above, with plug 10. The plug is retained in position by locking ring 11. Beaded inside the rod is copper pipe 23 for outlet of clean oil. The pipe other end enters the space of non-return valve, which prevents oil flow from the main oil gallery into the filter when the oil is primed before starting the engine.

Mounted in the filter body lower part is oil deflector shield 20 welded of two parts. The filter is closed with cover 6 secured by three studs.

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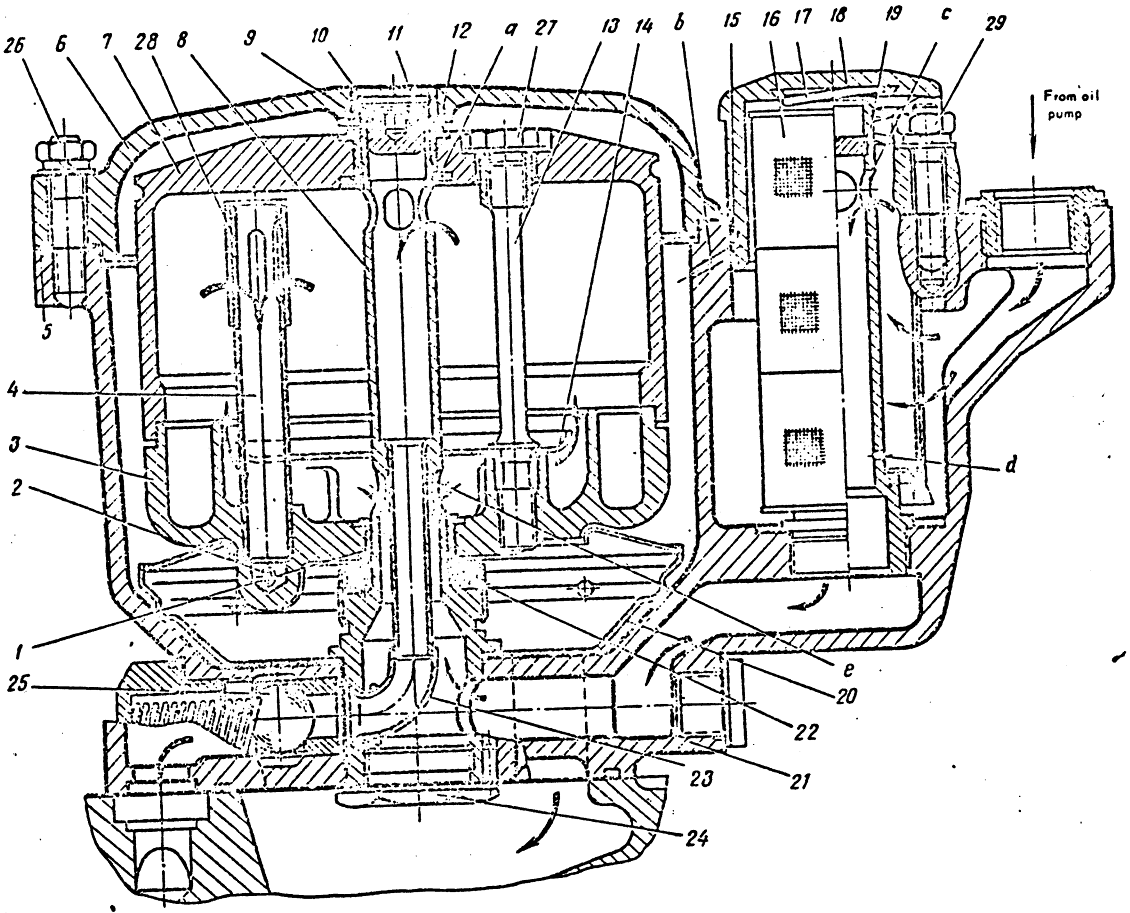
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FIG. 174. OIL CENTRIFUGAL FILTER

1, 12 - bronze bushings; 2 - injector; 3 - rotor cover; 4 - oil intake pipe; 5 - gasket; 6 - filter cover; 7 - rotor body; 8 - rotor rod; 9 - bushing; 10 - plug; 11 - locking ring; 13 - stud; 14 - shield; 15 - rubber ring; 16 - gauze cylinder; 17 - spring; 18 - cover of coarse filter; 19 - gauze filter rod; 20 - oil deflector shield; 21 - centrifugal filter body; 22 - bearing; 23 - clecned oil outlet pipe; 24 - stopper; 25 - non-return valve ball; 26 - cover attaching nut; 27 - rotor nut; 23 - protective net; 29 - cover nut; a, b, c, d, e - holes

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The filter operates as follows. From the oil pump from where it passes through the filtering gauze of cylinder 16 and radial holes "c" into the space of rod 19. From the rod space oil enters a channel in the bottom of the body and rises into the lower space of rotor rod 8 and fills the rotor inner space through holes "e". From the rotor space a portion of oil is fed in two oil intake pipes 4 installed in rotor cover 3. The oil intake pipes are closed from top by filtering gauze. Installed in the pipes from below are injectors 2, which are directed tangentially to the pipes generatrix.

Oil from the pipes flows at a great speed through the injector nozzles. Under the action of reactive forces built up by the oil stream, the rotor starts to rotate at a great speed. Depending on the oil pressure the rotor speed reaches 6000 - 9000 rpm.

Under the action of centrifugal forces heavier particles of admixtures contained in the oil are thrown to the periphery and settle down on the rotor inner walls; whereas a zone of clean oil is formed in the space close to the rotor axis. Clean oil passes via hole "a" into the space of rod 8, passes through pipe 23, presses off non-return valve ball 25 and through the outlet union gets in the engine oil gallery and for lubrication of the fuel injection advance angle setting coupling.

The oil priming pump МЗН-3 (Fig. 175) is designed to feed oil to the engine before its starting. It is bolted to the oil tank flange from the left-hand side.

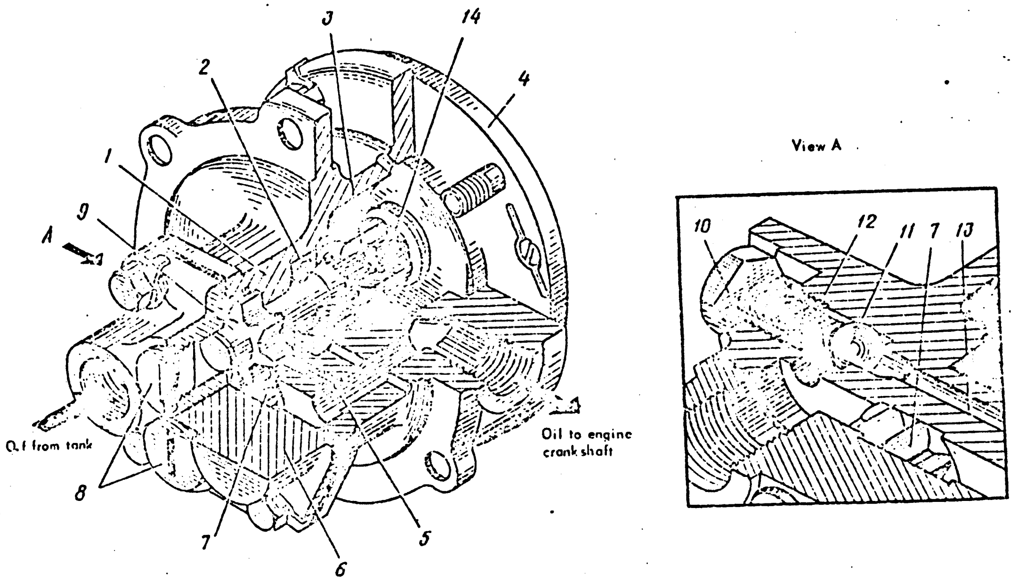

FIG. 175. OIL PRIMING PUMP МЗН-3

1 - pump body, 2 - spring-loaded oil seal; 3 - coupling; 4 - electric motor; 5 - by-pass valve channel; 6 - pump cover; 7 - driven gear; 8 - body plugs; 9 - driving gear; 10 - valve plug; 11 - valve ball; 12 - valve spring; 13 - channel; 14 - electric motor shaft

The gear type pump is driven by electric motor MH-1. The pump consists of body 1 housing two gears 7 and 9 and closed with cover 6. Driving gear 9 is made en bloc with the shaft, that is joined with motor 4 shaft by means of coupling 3.

Arranged in the pump is a ball-type by-pass valve with ball 11 and spring 12 adjusted to a pressure of 12 ± 2 kgf/cm^2.

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Oil from the tank flows by gravity via pump body channels into the intake gears 7 and 9 where it is caught by the gear tooth and delivered to the delivery chamber and thence to the main oil gallery of the engine. If the pressure in the oil gallery exceeds the permissible limits, by-pass valve ball 11 is pressed off and oil returns from the delivery chamber back into the intake chamber.

The oil cooler is of a fin-and-tube type. It is designed to cool the oil coming from the engine. It is installed in the ejector casing under armour louvers of the roof.

The cooler consists of packs of oval brass tubes with fitted-on cooling fins, tube plates and headers.

Arranged inside the tubes are corrugated plates serving for better dissipation of heat.

As the engine operates, the oil is fed from the oil pump to the radiator header and passing through the tubes is cooled by the flow of air sucked in the cooling system ejector.

For better cooling the inlet header is made of two halves. Oil passes through the first half of the tube packs and then through the second one. As a result, the distance of oil travel and, accordingly, the time of its cooling by the air flow are increased.

6.5.3. Operation of Lubrication System

When the oil priming pump МЗН-3 is switched on, oil from tank 6 (Fig. 171) passes throug gauze filter 10 and is fed to the engine through pipeline 11.

As the engine is started, oil pump 1 is immediately brought into action and starts to supply oil from the tank to the centrifugal filter.

From the filter the cleaned oil is supplied through the cylinder block-and-crankcase unit main oil gallery to drillings made in the crankshaft. The oil squeezed out of gaps of the crankpin bearings is splashed to lubricate the pistons, piston pins, connecting rod smal ends, cylinder liners and crankshaft antifriction bearings.

A portion of oil out of the main oil gallery is carried to the housing of the fuel injec tion advance angle setting coupling, from which it is fed through the pipes to the end faces of the cylinder heads. There the oil lubricates under pressure the thrust bearings of the camshafts and through radial drillings made in the journals and cams lubricates the shaft bearings, cams and valve discs.

From the cylinder heads oil drips into the accessory drive casing where it gets splashe by the rotating gears and lubricates the gear teeth and bearings.

A double clamp is screwed in the place where the oil is brought to the left-hand cylinder head. From there the oil is carried through a pipe to the air distributor.

From the casing of the fuel injection advance angle setting coupling oil is fed via a pipe to the fuel injection pump and then is drained into the cylinder block-and-crankcase unit through two by-pass pipes.

After lubrication of the engine friction parts, oil is drained into the cylinder block and-crankcase unit and is collected in the oil pan. From the oil pan oil is sucked by the o pump suction section and is delivered via pipeline 29 to cooler 19, from where it gets into tank 6 through pipe 20.

The water pump bearings are lubricated by oil mist which is formed as the oil is squee out of the bearing of the oil pump suction section central gear.

Gas and oil vapours accumulating in the oil tank are sucked off through the drain syst due to rarefaction in the ejector.

Pressure gauge 22 and thermometer 21 are intended for checking of the lubrication sys functioning.

6.5.4. Care of the Engine Lubrication System

Care of the engine lubrication system consists in:

- periodic checking of the instrument readings;
- checking and refilling of the system;

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[redacted]

- cleaning the assemblies of dust and dirt;
- refilling of the fuel injection pump governor;
- washing of fine and coarse oil filters;
- checking the cooler, oil tank, oil priming pump and pipelines for condition and fastening;
- replacement of oil in the system.

Sequence of Checking Oil Level and Refilling the System

For checking do the following:

(a) clean armour plug 8 (Fig. 14) on the vehicle roof of dust and dirt, uncotter and unscrew it;

(b) unscrew the union nut and take out dipstick 15 (Fig. 171), wipe it and insert again, then remove it and check the oil level. Perform the check not earlier than 15 minutes after the engine shutdown. The oil level must be above the lower mark on the dipstick.

While refilling the system, proceed as follows:

(c) uncotter and remove plug 4 (Fig. 172) of the oil tank filler neck;

(d) remove filtering gauze 6;

(e) insert the dispensing gun of the oil filling truck into the filler neck and refill the tank with oil up to the upper mark on the dipstick. In case an oil filling truck is not available, refill the system with oil heated up to 70-90°C using a bucket and a funnel with filter. In this case do not remove the filtering gauze from the oil tank filler neck;

(f) install the dipstick in place and screw up the plugs.

Sequence of Replacement of Oil in Lubrication System

Replace oil after 5000 km of the vehicle run, but at least every 250 h of the engine operation. To replace the oil, do the following:

(a) clean of dust and dirt armour plug 8 (Fig. 14) on the vehicle roof, uncotter and remove it;

(b) uncotter and remove the plug of the oil tank filler neck;

(c) clean armour plugs 7 and 9 (Fig. 13) of dust and dirt and remove them;

(d) uncotter and remove the plug of oil tank drain valve 32 (Fig. 171);

(e) screw the oil drain wrench into the drain valve body, having previously connected the hose to it and drain oil into a clean container; drain oil immediately after stopping the engine;

(f) remove the oil drain wrench together with the hose;

(g) screw in the oil tank drain valve plug and cotter it;

(h) uncotter and unscrew plug 14 (Fig. 135) from the drain hole of the engine crankcase and drain the remainder of oil into a container;

(i) screw the plug into the hole of the engine crankcase and cotter it;

(j) install armour plugs in the vehicle bottom;

(k) wash coarse and fine fuel filters;

(l) fill the oil tank with oil up to the level of the upper mark on the dipstick;

(m) switch on the oil priming pump by depressing button PUMP (НАСОС) on the central panel and build up a pressure of not less than 2 kgf/cm^2 in the system;

(n) start the engine and set the crankshaft speed at 800-1000 rpm, then stop the engine after 3-5 min of operation;

(o) check the oil level in the oil tank 15 min after the engine shutdown;

(p) screw in the plugs.

[redacted]

Washing of Oil Filters

The washing is performed after 2500 km of the vehicle run, but at least every 120 h of the engine operation.

To wash the filters, proceed as follows:

(a) unscrew the bolts securing the hatch cover above the engine and open it;

(b) unscrew the bolts securing the front ribbed plate of the hull and raise it until it is caught by the lock;

(c) disconnect rod 12 (Fig. 163) of the fuel feed control linkage from double-arm lever 9;

(d) unscrew three nuts 26 (Fig. 174) securing cover 6 of the centrifugal oil filter;

(e) remove the cover and rotor from the filter body;

(f) holding the rotor with the wrench for disassembly of the centrifuge, unscrew two nuts 27 in turn through five revolutions;

(g) lightly striking with hammer the end faces of nuts 27 one after another, detach rotor body 7 from rotor cover 3;

(h) completely unscrew nuts 27 and disassemble the rotor;

(i) remove protective nets 28 from oil intake pipes 4;

(j) remove the deposit from rotor body 7 inner surface by means of a wooden scraper and wash it with clean diesel fuel;

(k) wash the oil intake pipes and protective nets with clean diesel fuel; check the nozzle holes of injectors 2 for cleanliness, thoroughly clean them using a soft metal (copper or aluminium) wire and afterwards blow them through with compressed air;

(l) put the protective nets on the oil intake pipes so that the net seam is not aligned with the pipe hole;

(m) connect the rotor body with the cover so that the check pin in the rotor cover gets in the slot of the rotor body (if the check pin is not available, align the marks on the side surfaces of the rotor body and cover);

(n) screw nuts 27 on the studs bearing the numbers identical to the nut numbers;

(o) holding the rotor with the wrench for disassembly, tighten nuts 27 so that the marks on the nut and rotor are aligned;

(p) insert the rotor into the filter body and check it for easy rotation; the rotor must rotate freely and without jamming when pushed by hand;

(q) install cover 6 on the filter body;

(r) tighten up the nuts securing the oil filter cover and place spring washers under the nuts;

(s) unscrew the inspection hole plug from cover 6 and check the rotor for ease of rotation;

(t) screw in and cotter the inspection hole plug;

(u) unscrew two nuts 29 securing cover 18 of the coarse oil filter and remove the cover together with spring 17;

(v) remove gauze cylinder 16, wash it with clean diesel fuel and blow off with compressed air;

(w) insert the filtering element into the filter housing and assemble the filter;

(x) connect the rod of the fuel feed control linkage with the double-arm lever;

(y) start the engine, warm it and check the filter for leakage;

(z) stop the engine and place the ribbed plate in position.

Sequence of Checking and Refilling of Fuel Injection Pump Governor

To check and refill the governor, proceed as follows:

(a) open the hatch cover above the engine;

[redacted]

[redacted]

(b) uncotter and unscrew plug

governor; wipe the dipstick and place it back;

(c) remove the dipstick and check the level; the oil level must be between the upper and lower marks;

(d) if necessary, refill oil using a syringe.

In case the oil is dirty or thinned, replace it, proceeding as follows:

(a) using a syringe, suck oil from the governor housing, having fitted an 8-mm dia. rubber pipe having a length of about 150-200 mm on the syringe nose;

(b) fill approximately 250 cm^3 of clean oil through a funnel with gauze;

(c) check the level by the dipstick; reinstall the plug and cotter it.

Washing of Oil Priming Pump Filtering Gauze

To wash the filtering gauze, proceed as follows:

(a) remove cover 8 (Fig. 13) of the hatch under the engine;

(b) unscrew the union nut of the oil priming pump intake branch pipe from the tank union;

(c) shift aside the disconnected branch pipe with oil priming pump-to-engine pipeline 11 (Fig. 171);

(d) unscrew oil priming pump filter from the oil tank, having previously uncottered it;

(e) wash the filter in clean diesel fuel;

(f) install the oil priming pump filter in position and cotter it;

(g) connect the branch pipe with the pipeline to the filter body and screw the union nut on the filter body;

(h) cotter the union nut;

(i) start the engine, warm it and check for leakage;

(j) reinstall the hatch covers.

6.6. COOLING SYSTEM

6.6.1. Purpose

The liquid cooling system of the engine (Fig. 176) is of a closed, high temperature type with forced circulation and ejection cooling of radiators. The system provides for dissipation of heat from the engine parts contacting hot gases and maintains their temperature within permissible limits.

6.6.2. Design

The system includes pump 2, radiator 10, expansion tank 12, cooling jackets of cylinders and combustion chambers, an ejector, pipelines and a thermometer.

The cooling system centrifugal pump is installed below on the right side of the cylinder block-and-crankcase unit. It is secured to the oil pump cover-flange by means of four studs 18 (Fig. 177). Shaft 1 rotates in two ball bearings 13 in the pump aluminium body. Fitted over the splines on one end of the shaft is splined bushing 14 driven by means of a resilient shaft from middle gear 3 (Fig. 173) of the oil pump suction section. The other end of the shaft carries impeller 3 (Fig. 177). The front part of the pump body is volute-shaped, with the impeller rotating inside.

Packing of the pump shaft consists of disc 20 with a cerametallic ring, graphite sealing ring 10, rubber ring 9 and spring 19. From the other side the packing is effected by means of cup 11 and oil deflector washer 12.

Two holes "c" are intended for checking of operation of the packing. Holes "a" facilitate removal of the oil seal from the impeller side.

[redacted]

The coolant is fed by gravity in the pump from the radiator through bell 2. It is caught by the blades of impeller 3, thrown to the periphery and forced in the cooling system channel via the branch pipe, directly joined to the cylinder block-and-crankcase unit.

Radiator 10 (Fig. 176) is of a fin-and-tube type. It is arranged in the ejector casing under the oil coolers and is attached to it by clamping bands.

The radiator consists of packs of brass tubes having oval cross-section, cooling fins that are fitted onto the tubes, tube plates and headers. Headers 23 are partitioned into four sections, providing for successive passage of liquid through the packs of tubes, thus intensifying the cooling process.

One of the headers mounts two branch pipes 24 and 25 and union 26. Connected to one branch pipe is pipeline 27 running from the branch pipes of the cylinder heads, the other is used for connection of the pump pipelines.

Union 26 is intended for connecting steam release pipe 28, the other end of which enters expansion tank 12.

Expansion tank 12 is designed for filling the cooling system, for collecting and condensing the steam pressed out of the cylinder jackets, cylinder head cooling spaces and radiators, and for building up a constant pressure of coolant at the water pump inlet. The tank is arranged above the engine and is bolted to a detachable girder of the hull.

Welded to the tank bottom is branch pipe 1 (Fig. 178) connected with the pipeline running to the water pump.

Welded into the tank side walls are unions 3 for connection with steam release pipes 2.

Arranged inside the tank is a measuring rule for checking of the coolant level. The measuring rule has three steps "a", "b" and "c" used for checking coolant level.

The tank filler neck is closed with a cap with a vacuum-and-pressure relief valve.

The valve is designed for communication of the tank with atmosphere. It consists of body 11, steam valve body 10 with a stem and spring 9, steam valve 14, air valve 13 with spring 16 and the spring support.

When the pressure in the cooling system grows and exceeds 1.8 - 2.2 kgf/cm^2, steam valve 14 is lifted off its seat compressing spring 9 and a portion of steam escapes outside through slot "d" and hole "e".

As soon as the coolant cools down or its level drops, the pressure is decreased and some rarefaction forms in the cooling system. As the rarefaction reaches 0.06 - 0.1 kgf/cm^2 air valve 13 lowers, compressing spring 16, and the air comes from outside in the expansion tank.

The ejector (Fig. 179) is intended to create a flow of cooling air through the radiators by means of utilizing the energy of the engine exhaust gases.

The ejector is located in the engine compartment and is attached to the hull transvers girders. The ejector consists of casing 6 with the inner partitions, two outlet manifolds 1 with six nozzles 13 in each, ball compensators 14 and valve boxes 21.

Ejector manifolds 10 are joined with the engine exhaust manifolds through a system of pipelines by means of ball compensators 14.

The ejector casing has a hole closed with shutter 12. The hole is intended for intake of air from the ejector casing in winter and directing it to the air cleaner.

A cock for draining water from the ejector casing is connected with drain valve 12 (Fig. 20) located in the vehicle bottom near the vehicle right side in the fighting compar ment close to the preheater exhaust gas outlet hole.

Secured to the ejector casing side is engine compartment gas suction ejector 29 (Fig. 179) closed with valve 17.

The valve serves to prevent ingress of water in the engine compartment while negotiating water obstacles when the engine is shut down. Secured near ejector 29 is ejector 26 fo suction of dust from the air cleaner dust colllector.

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Insert 18

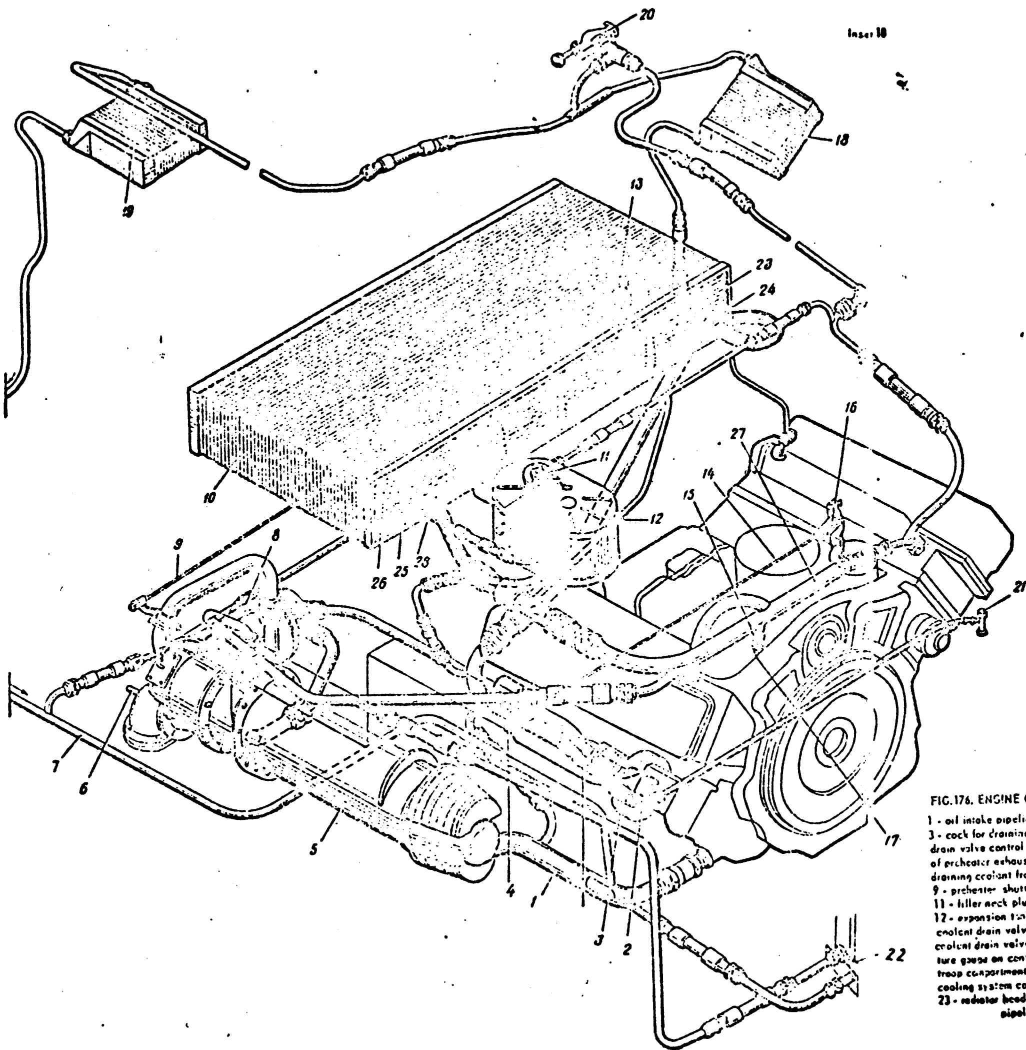

FIG. 176. ENGINE COOLING AND PREHEATING SYSTEM

1 - oil intake pipeline warming jacket; 2 - engine water pump; 3 - cock for draining coolant from water pump and system; 4 - drain valve control cable roller; 5 - preheater boiler; 6 - handle of preheater exhaust gas outlet hole cover; 7 - pipeline for draining coolant from heater radiators; 8 - preheater pump unit; 9 - preheater shutter control cable; 10 - cooling system radiat 11 - filler neck plug with vacuum-and-pressure relief valve; 12 - expansion tank; 13 - preheater shutter control handle; 14 - coolant drain valve cable; 15 - thermometer sending unit; 16 - coolant drain valve control handle; 17 - wire running to temper ture gauge on control panel; 18 - front heater; 19 - radiator of troop compartment heater; 20 - heaters cut-off cock; 21 - cooling system coolant drain valve; 22 - gearbox warming pan 23 - radiator header; 24, 25 - branch pipes; 26 - union; 27 - pipeline; 28 - steam release pipe

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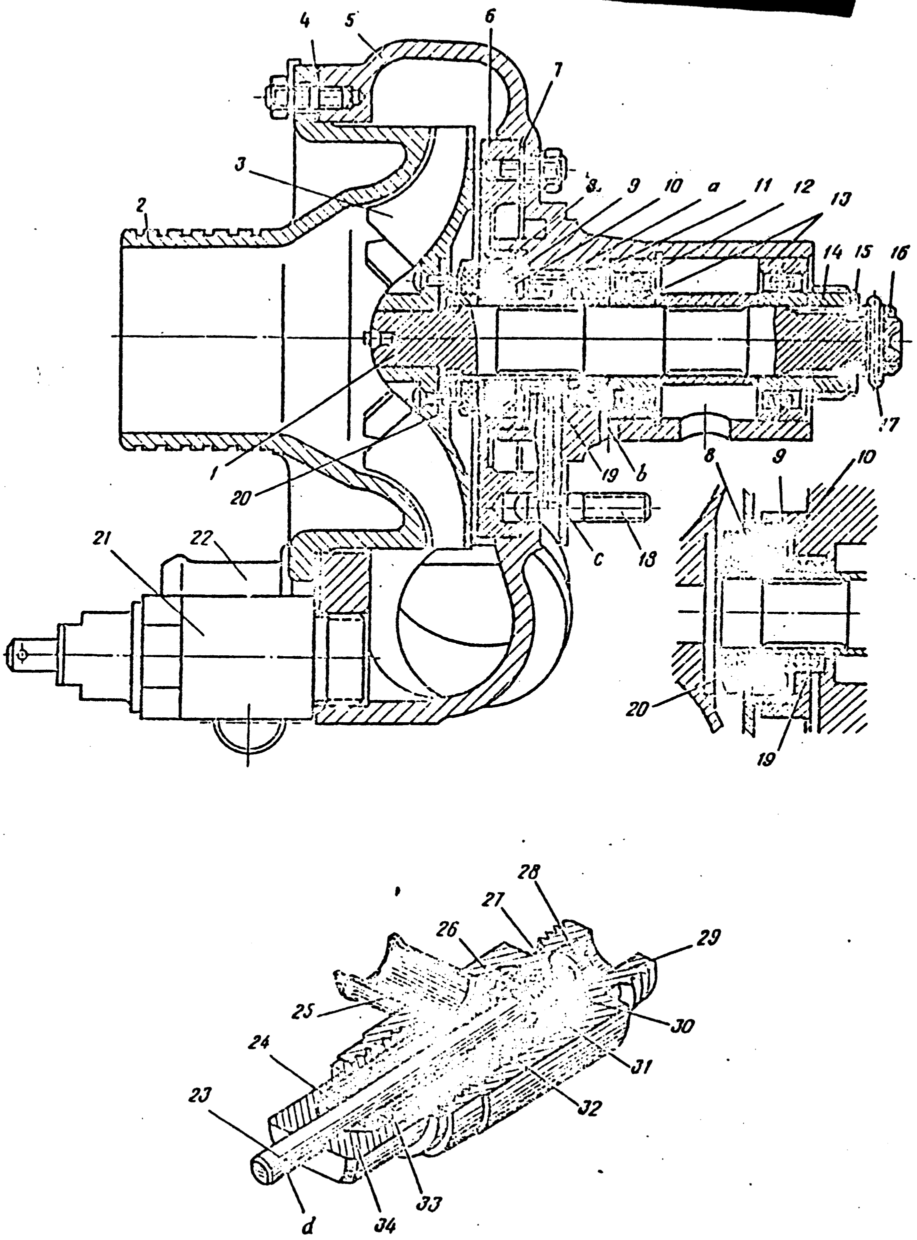
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FIG. 177. WATER PUMP

1 - water pump shaft; 2 - bell; 3 - impeller; 4, 7 - gaskets; 5 - water pump body; 6 - flange; 8 - holder; 9 - rubber ring; 10 - sealing ring; 11 - cup; 12, 15, 27 - washers; 13 - ball bearings; 14 - splined bushing; 16 - nut; 17 - cotter pin; 18 - studs; 19, 32 - springs; 20 - sealing disc; 21 - drain cock; 22, 29 - unions; 23 - cock rod; 24 - packing; 25 - branch pipe; 26 - cock body; 28 - valve nut; 30 - valve; 31 - ring; 33 - bushing; 34 - pressure nut; a, b, c - holes; d - drilling

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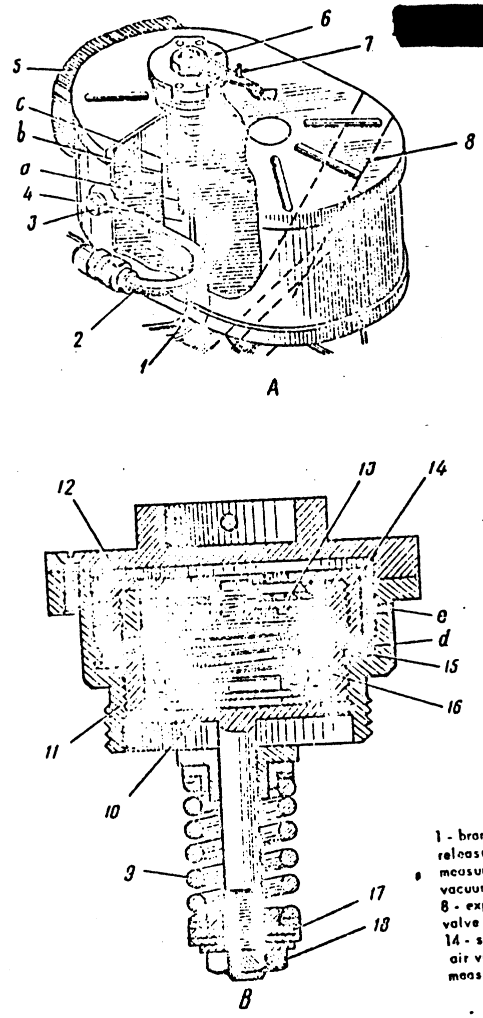

FIG. 178. EXPANSION TANK

A - tank; B - cap

1 - branch pipe from tank to system pipeline; 2 - steam release pipe; 3 - steam release pipe union; 4 - measuring rule; 5 - attaching bracket; 6 - cap with vacuum-and-pressure relief valve; 7 - locking wire; 8 - expansion tank; 9 - steam valve spring; 10 - steam valve body; 11 - cap body; 12 - cover; 13 - air valve; 14 - steam valve; 15 - steam valve rubber seat; 16 - air valve spring; 17 - bushing; 18 - nut; a, b, c - measuring rule steps; d - slot; e - hole for communication with atmosphere

Connected to the dust suction ejector is pipe 20 communicating the spaces of compensators of outlet manifolds with the ejector diffuser, thus a provision is made for suction of gases and condensate from the compensators of the ejector outlet pipes.

The control linkage of valve 17 is coupled with the engine protection valves linkage. The valve is closed together with the engine protection valves when the engine is stopped. The valve is opened manually by means of handle 5 (Fig. 15) of the engine protection valves control linkage.

Gases are evacuated from the oil tank through pipeline 22 (Fig. 179), which communicates the tank with the ejector casing. The gas suction system includes safety valve 25 protecting the oil tank against ingress of water.

The ejector operates as follows. Engine exhaust gases coming out of outlet manifolds 10 through twelve nozzles 13 pass the ejector casing diffuser and create rarefaction in the space under the radiators. As a result, air is sucked through the radiators and cools them. Simultaneously, rarefaction provides for suction of dust from the dust collector and gases are sucked from the engine compartment and oil tank.

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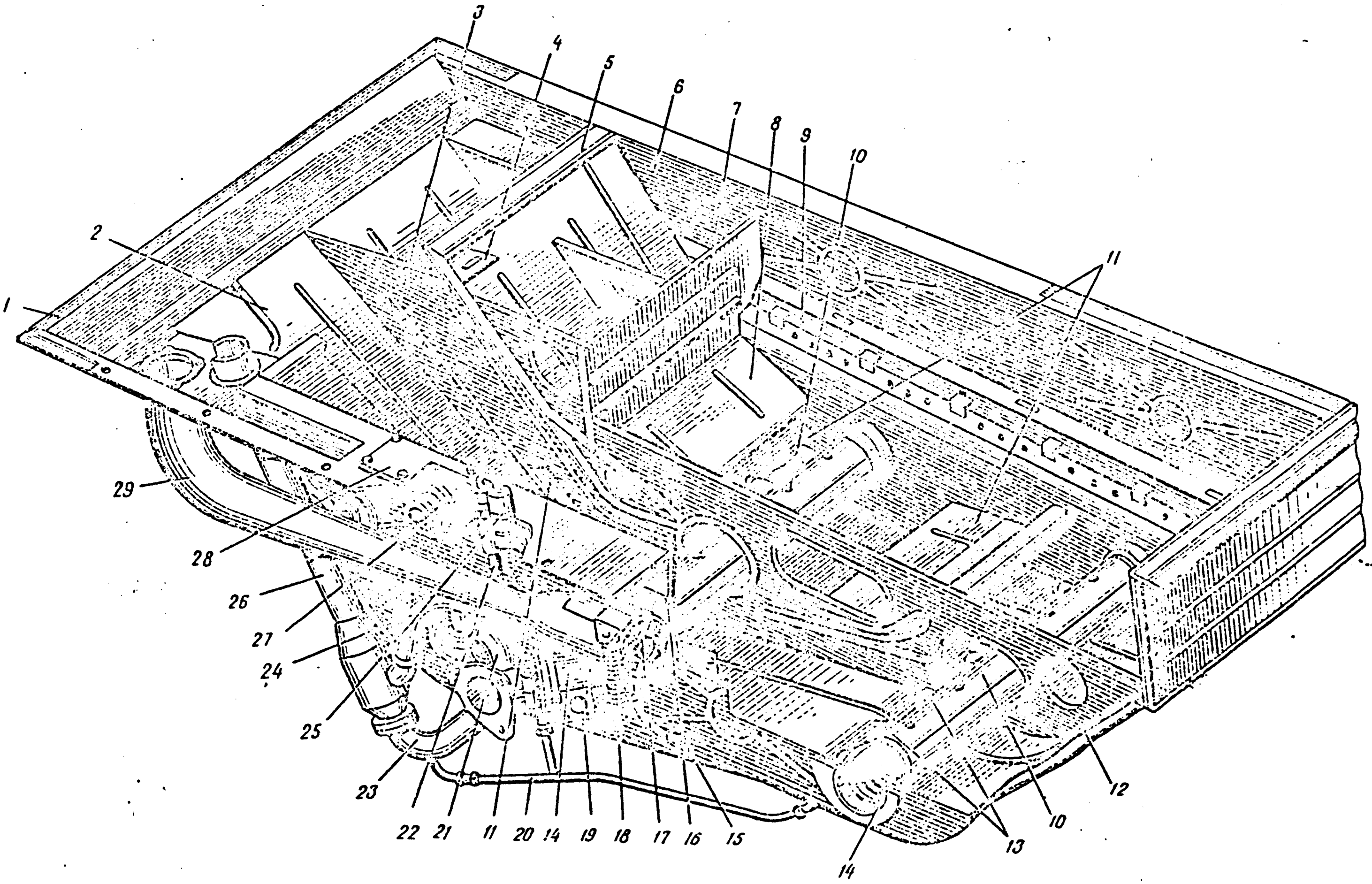

FIG.179. EJECTOR

1 - packing gasket; 2 - dividing partition; 3 - longitudinal partition; 4 - handle; 5 - packing against penetration of exhaust gases to radiators; 6 - ejector casing; 7 - lateral partition; 8 - diffuser wall; 9 - radiator bed; 10 - ejector outlet manifolds; 11 - dividing partition; 12 - shutter of winter air intake channel; 13 - exhaust gas outlet nozzles; 14 - ball compensators; 15 - exhaust gas supply pipe to engine compartment gas suction ejector; 16 - radiator band attaching hook; 17 - engine compartment water protection valve; 18 - protection valve spring; 19 - smoke-generating equipment injector mounting flange; 20 - condensate and gas suction pipe of ball compensators; 21 - valve box; 22 - oil tank gas suction pipeline; 23 - dust collector suction pipe; 24 - exhaust gas supply pipe to dust suction ejector; 25 - non-return (safety) valve; 26 - dust suction ejector; 27 - rubber cup for sealing of pipelines; 28 - access hole cover; 29 - engine compartment gas suction ejector

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[redacted]

The louvres protect the engine compartment units from being hit by the bullets and fragments. Besides, the louvres are used to control the temperature conditions of the engine operation.

The louvres are located above the radiators, being actually an armour grate, consisting of two groups of movable and fixed armour plates fitted in a frame.

The movable plates are interconnected by means of cranks and rod 24 (Fig. 180) with a fork.

Two shutters 2 are arranged above the ejector outlet part. Fixed strap 40 is secured between the shutters.

Under normal conditions the louvres and shutters are controlled manually. Besides, a provision is made for automatic closing of the louvres when the protection system operates.

The control linkage comprises manual control handle 34 (Fig. 6) located in the driving compartment on the driver's right, cable 35 (Fig. 180), springs 26, 32 and 36, a bridge and linkage disengagement mechanism 23 that controls automatic closing.

The manual control linkage operates as follows: when handle 10 is turned upwards, rod 14 turns double-arm lever 15 that turns lever 31 and bushing 29 of camshaft by means of rod 17 and linkage disengagement mechanism 23.

When bushing 29 is turned, cam 34 and lever 27 are also displaced. Lever 27 actuates double-arm lever 25 that pulls rod 24. While turning, lever 33 with roller pulls cable 35 and closes ejector shutters 2.

As the lever heads fitted on the axles of movable plates enter the seats of rod 24, the rod movement closes the plates.

During the initial stage of turning, cam 34 does not actuate the roller of lever 33, but later it begins to press the roller, turns lever 33 and pulls cable 35 that closes ejector shutters 2, thus providing for successive operation of the shutters.

Louvres and shutters automatic closing mechanism comprises electromagnet ПЛ-1 (Fig. 181), support bracket 3, a body, a locking device and spring 13.

The locking device consists of rod 4 screwed on the thread of the screw that is hinge-joined with electromagnet end-piece 2, four balls 5 fitted in the grooves of rod end-piece 7 and connecting body 6 with the end-piece. The balls are retained in the grooves with a lug of rod 4 pressed by spring 13 through nut 12. When the balls are located in the grooves, the mechanism operates as one unit joining linkage rod 17 (Fig. 180) with lever 31 by means of ball pin 9 (Fig. 181) and fork 16.

As the protection system operates, current is fed to the electromagnet and the armature together with rod 4 displaces towards the electromagnet. The rod lug comes from under balls 5, the balls get out of the grooves, thereby uncoupling body 6 from rod end-piece 7. As a result, under pressure of springs 26 and 36 (Fig. 180) the ejector louvres and shutters get closed.

To return the mechanism to the working position, switch off the antiatomic protection system switch, set latch 11 on manual control linkage handle 10 to the vertical position and shift the handle to position CLOSED (ЗАКРЫТО) and then to position OPEN (ОТКРЫТО). This done, shift latch 11 to the horizontal position.

Two heaters are mounted in the vehicle. Radiators of the heaters are included in the cooling system. Description of the heaters is given in Section 11.

The heaters are cut in and off by means of cock 20 (Fig. 176) installed in the bay on the vehicle commander's left, behind the filter-ventilating unit. The cock consists of body 3 (Fig. 182), stem 9, valve 4, spring 10 and handle 8 with eccentric 6.

To open the cock, shift handle 8 to position "O". As this takes place, eccentric 6 thrusts against the body and moves stem 9 with valve 4 from the seat, thus opening access of hot liquid through supply union 2 and union 1 to the heater. Heating is performed due to dissipation of heat to the surrounding air by the radiator.

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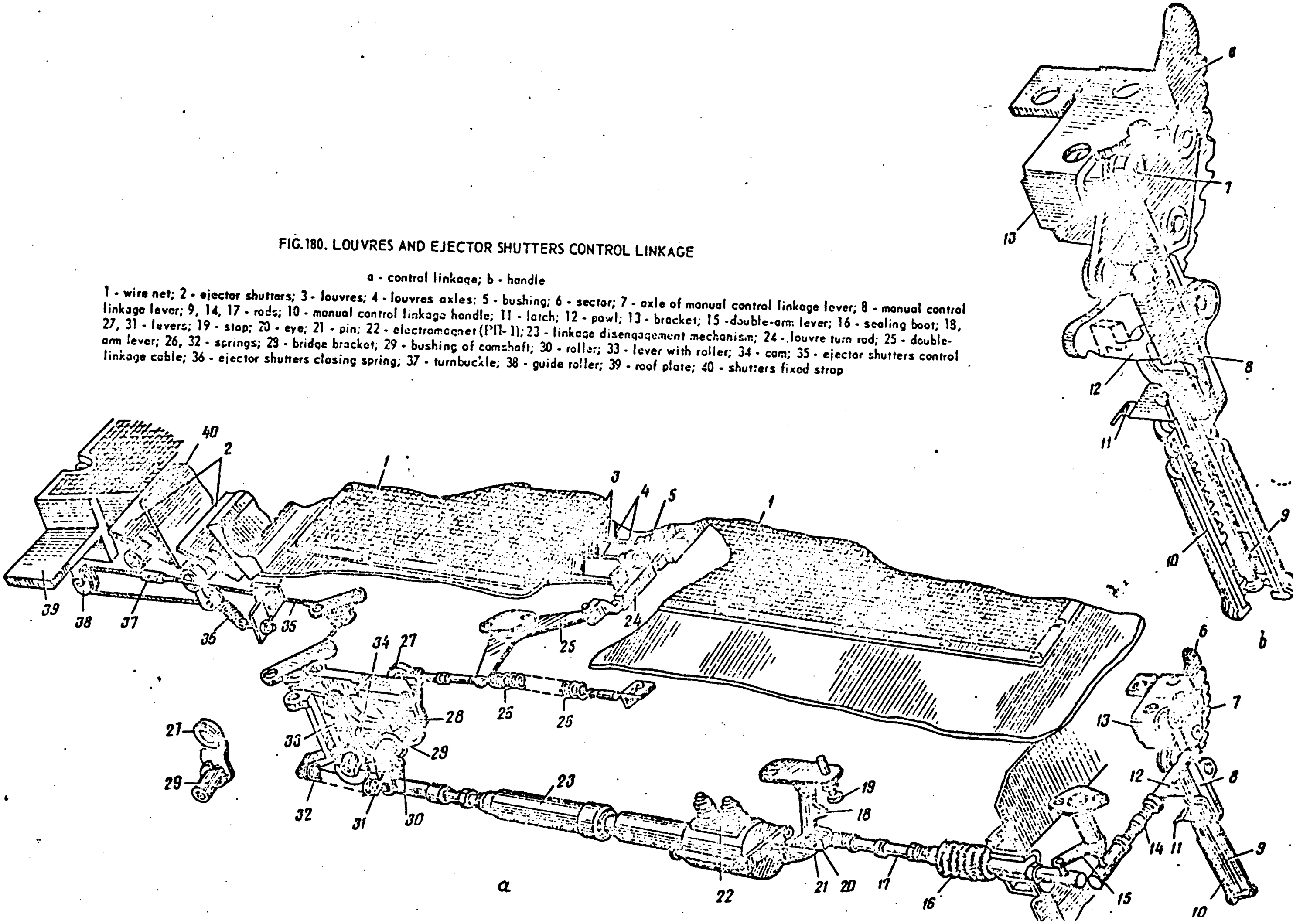
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FIG.180. LOUVRES AND EJECTOR SHUTTERS CONTROL LINKAGE

a - control linkage; b - handle

1 - wire net; 2 - ejector shutters; 3 - louvres; 4 - louvres axles; 5 - bushing; 6 - sector; 7 - axle of manual control linkage lever; 8 - manual control linkage lever; 9, 14, 17 - rods; 10 - manual control linkage handle; 11 - latch; 12 - pawl; 13 - bracket; 15 - double-arm lever; 16 - sealing boot; 18, 27, 31 - levers; 19 - stop; 20 - eye; 21 - pin; 22 - electromagnet (PП-1); 23 - linkage disengagement mechanism; 24 - louvre turn rod; 25 - double-arm lever; 26, 32 - springs; 28 - bridge bracket; 29 - bushing of camshaft; 30 - roller; 33 - lever with roller; 34 - cam; 35 - ejector shutters control linkage cable; 36 - ejector shutters closing spring; 37 - turnbuckle; 38 - guide roller; 39 - roof plate; 40 - shutters fixed strap

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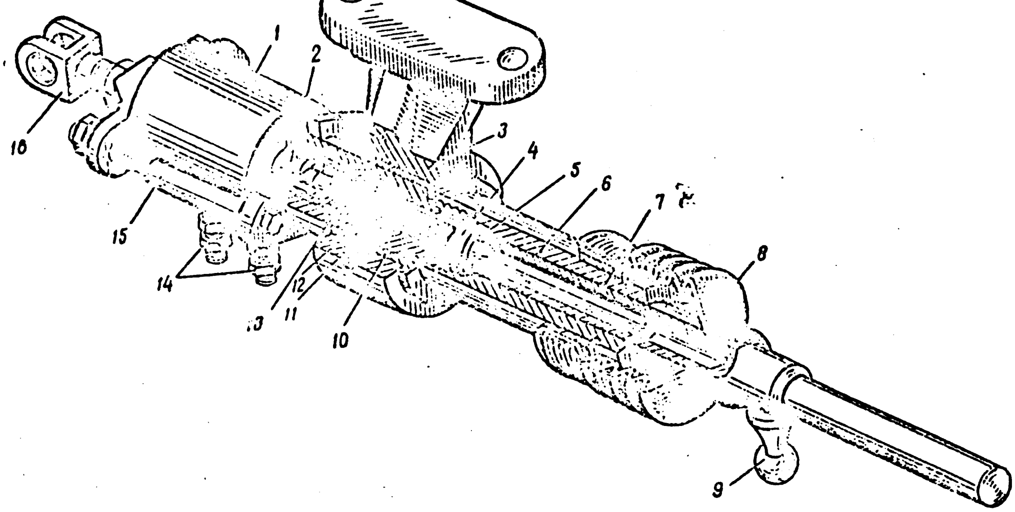

FIG. 181. LOUVRES AUTOMATIC CLOSING MECHANISM

1 - electromagnet; 2 - end-piece of electromagnet armature; 3 - support bracket; 4 - locking device rod; 5 - locking device balls; 6 - body; 7 - rod end-piece; 8 - protective boot; 9 - ball pin; 10 - bushing; 11 - adjusting shims; 12 - shaped nut; 13 - spring; 14 - terminals; 15 - electromagnet attaching bolt; 16 - rod fork

Cock 21 (Fig. 177) for draining coolant from the engine is installed in a boss on the water pump body. The cock comprises body 26, rod 23 with rubber valve 30 at the end and pressure nut 34.

Spring 32 presses valve 30 to the seat in the cock body. Cock body 26 is screwed in the pump body with union 29. Coolant is drained through branch pipe 25.

To drain the coolant, pull rod 23 by means of a ring fitted in drilling "d" at its end.

From the drain cock the coolant is drained through the drain valve installed on the engine compartment bottom.

The drain cock is opened by means of a cable linkage with control handle 49 (Fig. 6) arranged on the engine compartment bulkhead.

When handle 49 is moved to position "0", cable 14 (Fig. 176) pulls rod 23 (Fig. 177) th carries valve 30, thus opening passage of water from the pump to the pipeline leading to the drain valve.

Valve 52 (Fig. 6) for draining of coolant from the cooling system is installed in the vehicle bottom to the right and behind the driver's seat. The valve comprises body 5 (Fig. 183), stem 6 with valve 1, spring 3 and cap 4 screwed on the thread of stem 6.

To open the valve, depress cap 4, and valve 1 will open passage of the coolant from branch pipe 7 to the outside. The valve is locked in the open position by turning the cap clockwise.

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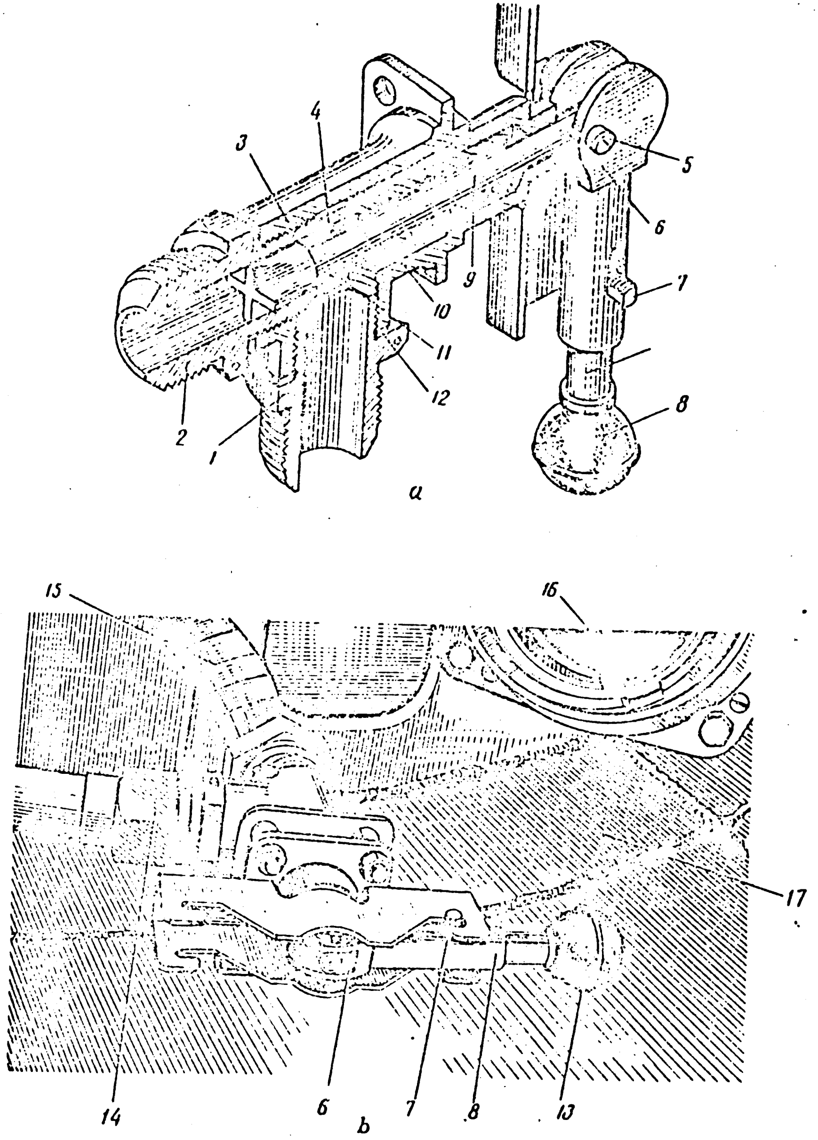

FIG. 182. HEATERS CUT-OFF COCK

a - cock; b - installation of cock in vehicle

1 - outlet union; 2 - supply union; 3 - heater cock body; 4 - valve; 5 - eccentric axle; 6 - eccentric; 7 - handle retainer; 8 - cock handle; 9 - valve stem; 10 - valve spring; 11 - packings; 12 - gasket; 13 - handle head; 14 - union nut; 15 - coolant outlet flexible hose; 16 - machine gun ball mount; 17 - hull side plate

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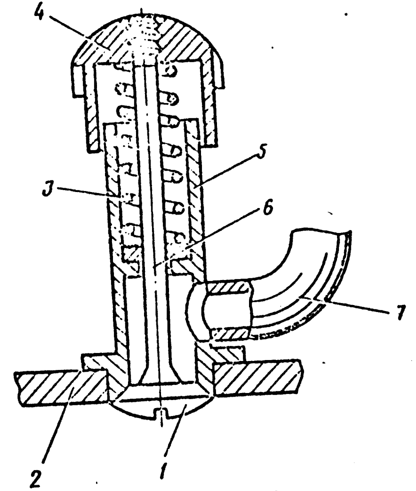

FIG. 183. DRAIN VALVE

1 - valve, 2 - vehicle bottom; 3 - spring; 4 - cap; 5 - valve body; 6 - valve stem; 7 - inlet branch pipe

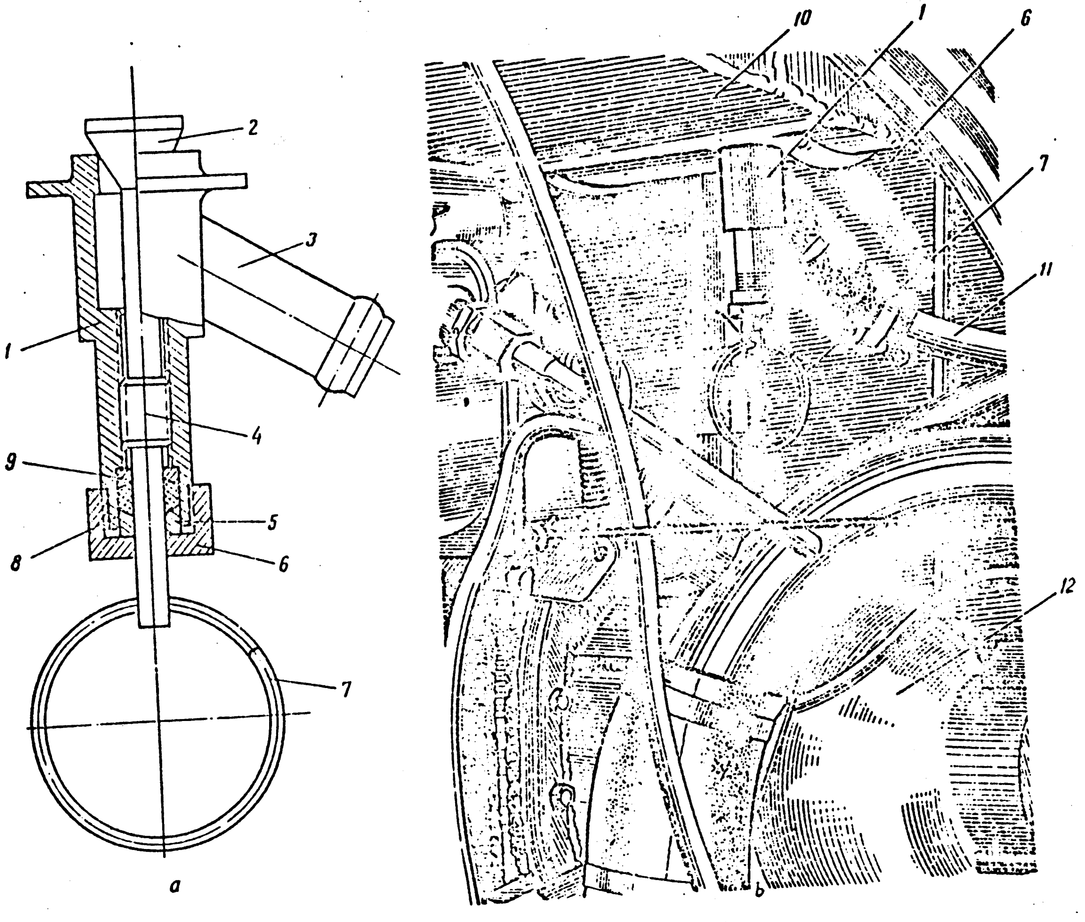

FIG. 184. EJECTOR CASING WATER DRAIN COCK

a - cock; b - arrangement of cock

1 - cock body; 2 - cock cone; 3 - inlet branch pipe; 4 - valve, 5 - pressure bushing; 6 - union nut; 7 - ring; 8 - packing; 9 - washer; 10 - ejector casing; 11 - pipeline to drain valve, 12 - preheater boiler

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from the ejector casing is installed in its bottom and consists of body 1 (Fig. 184) with branch pipe 3, valve 4 with cut-off cone 2, union nut 6, ring 7 and packing 8.

To open the cock, rotate valve 4 in clockwise direction by means of ring 7.

Valve 12 (Fig. 20) for draining water from the ejector casing is installed on the right side on the fighting compartment bottom close to the engine compartment bulkhead. The valve design is identical to that of the valve for draining water from the cooling system.

6.6.3. Operation of Cooling System

When the engine operates, the water pump delivers the coolant into the cylinder block-and-crankcase unit channels, from where it gets in the cylinder jackets and cooling spaces of the cylinder heads, thus cooling the cylinders, walls of combustion chambers and the injector sockets. The heated coolant passes through a union, an elbow bend in the engine upper part and a pipeline to the radiator and then returns to the pump.

Steam accumulating in the upper part of the cylinder heads is directed to the expansion tank.

The vehicle is equipped with a system for additional pumping of coolant that serves to protect the engine from overheating after stopping.

The coolant is pumped by the preheater water pump.

The pump electric motor is cut in automatically by means of a relay located in relay box KP-65.

Fig. 185 shows the electric motor connection circuit.

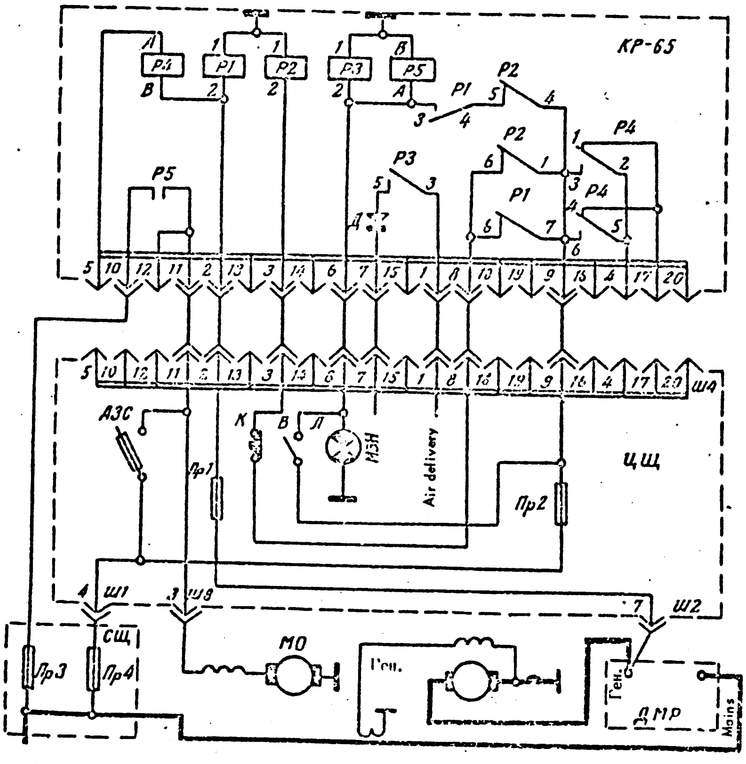

FIG. 185. DIAGRAM OF PREHEATER WATER PUMP CONNECTION FOR PUMPING WATER THROUGH ENGINE COOLING SYSTEM

P1, P2, P3, P4, P5 - relays in relay box KP-65; Д - diode; АЗС - automatic circuit breaker ENGINE PREHEATING (ОБОГРЕВ ДВИГАТ); Л - signal lamp ENGINE COOLING (ОХЛАЖД. ДВИГАТ); Пр1 - fuse (Пр6-10А); Пр2 - fuse (Пр3-5А); Пр3 - fuse (Пр14-50А); Пр4 - fuse (Пр11-100А); МЗН - oil priming pump; МО - preheater electric motor; Ген. - generator; КР-65 - relay box; ЦЩ - central panel; СЩ - power panel; ДМР - differential minimum relay

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When the engine stops, the generator is cut off from the vehicle mains, thus deenergizing relay P1, as the winding of relay P1 is connected to the generator. In this case contacts 3-4 of relay P1 close, contacts 6-7 open and relay P5 gets energized through closed contacts 3-4 of relay P1 and contacts 4-5 of relay P2.

Contacts of relay P5 close and current is supplied to the preheater electric motor. Thanks to this arrangement, the coolant is circulated and dissipates the heat in radiators, thus preventing engine overheating.

The preheater water pump may be switched on manually. To this end, cut in the ENGINE COOLING (ОХЛАЖД. ДВИГАТ.) switch B on the central control panel. In this case relay P5 gets energized and its contacts close, thus feeding the preheater electric motor.

To cut off the preheater electric motor, that has been automatically switched on, after the coolant temperature decreases, depress the ENGINE COOLING OFF (ВЫКЛ. ОХЛАЖД. ДВИГАТ.) button K on the central panel, breaking supply circuit of relay P2 and its contacts 4-5 get open. As a result, relay P5 is deenergized and the preheater electric motor is cut off.

If the preheater electric motor was switched on manually by means of switch B, set the switch to position OFF for switching off the motor.

6.6.4. Care of Cooling System

General

Care of the cooling system consists in:
- periodic checking of the coolant level in the expansion tank;
- watching the thermometer readings;
- checking the radiators for cleanliness and cleaning them periodically;
- checking the pipelines, radiators and their joints for leakage;
- checking the vacuum-and-pressure relief valve and louvres and shutters control linkage for proper adjustment;
- timely draining water from the ejector casing;
- checking of air intake pipe and ejector shutter control linkage for proper operation;
- timely opening the shutter of the winter air intake channel.

Checking of Coolant Level and Refilling of Cooling System

To check the coolant level, proceed as follows:

(a) clean plug 7 (Fig. 14) on the engine compartment roof of dust and dirt, uncotter and unscrew it;

(b) screw out the cap with the vacuum-and-pressure relief valve and check the coolant level in the expansion tank through the filler neck; the water level must be aligned with the edge of middle step "b" (Fig. 178) of the measuring rule or it must be at a distance of 65 mm from the filler neck upper edge. The level of the cold antifreeze must be aligned with the edge of lower step "c" of the measuring rule or it must be at a distance of 80 mm from the filler neck upper edge.

If the coolant level is lower, perform refilling as follows:

(c) take a funnel from the SPTA set and join an extension to it;

(d) fill the system:

in summer - with clean fresh water containing three-component additive;

in winter - with antifreeze grade 40 or 65 (GOST 159-52);

(e) reinstall the plugs.

If a complete filling of the system is required, in addition do the following:

(f) open heaters cut-off cock 20 (Fig. 176);

(g) fill the system;

(h) start the engine and run it for 3-5 min at a speed of 800-1000 rpm;

[redacted]

[redacted]

In this case:

- at ambient air temperature from +5 to -30°C fill water, that has been previously heated up to 80-90°C, quickly passing the hot water until water pump body gets warmed up and hot water starts flowing from the drain hole; for this purpose, first open drain valve 52 (Fig. 6) by depressing and turning it clockwise as far as it will go; open also drain cock 49 of the engine water pump;
- at ambient air temperature of -30°C and below fill the cooling system with antifreeze, start and warm up the engine and then stop it; drain the antifreeze in a prepared container and fill the cooling system with water heated up to 80-90°C; use the drained antifreeze for warming up of other vehicles.

ATTENTION! Before filling the cooling system with water in winter, close the cocks of the heaters. The cocks must be closed throughout the period the vehicle is operated with the cooling system filled with water.

Cleaning of Ejector Louvres and Shutters Control Linkage

For cleaning, do the following:

(a) unscrew the bolts securing the hatch cover above the engine and open it;

(b) unscrew the bolts securing the net above the ejector and remove the net;

(c) using waste soaked in diesel fuel, clean carbon deposit from ejector shutters 2 (Fig. 180) and the roof parts that contact the shutters, cam 34, roller 30 and louvres axles 4;

(d) wipe dry the cleaned surfaces with clean waste;

(e) close the hatch cover above the engine and secure it;

(f) install the net above the ejector and secure it.

Sequence of Tightening the Nuts Securing Valve Boxes 21 (Fig. 179) of Engine Protection Mechanism and Nuts Attaching the Hoops of Ball Compensators 14

To tighten the nut, proceed as follows:

(a) remove the bolts securing the front ribbed plate and raise it until it is locked;

(b) open the hatch cover above the engine;

(c) uncotter the nuts securing the valve boxes;

(d) fit 47-mm wrench socket on the wrench extension and tighten one bolt on each valve box holding the nuts. Then fit a 19-mm socket and tighten two nuts on each valve box holding the bolts from turning. Cotter the nuts.

Note. Tighten the extreme left-hand bolt of the left-hand valve box from the driving compartment through the access hole in the engine compartment bulkhead;

(e) uncotter the nuts of hoops of ball compensators;

(f) using a wrench extension with 17-mm socket tighten the nuts through the hatch above the engine and cotter them; when cottering align the holes for the cotter pin by turning the nuts in the direction of tightening only;

(g) place the covers in position.

6.7. ENGINE PREHEATING SYSTEM

6.7.1. Purpose

The preheating system is of liquid type. It is designed to prepare the engine for starting and maintain it in readiness for starting under lower temperature conditions. The system incorporates a preheater and pipelines.

[redacted]

6.7.2. Design

The injector-type preheater (Fig. 186) with a fire-tube boiler is mounted in the vehicle engine compartment. It comprises the preheater boiler with a combustion chamber and a pump unit.

The preheater boiler is a welded cylindrical structure built in the oil tank and bolted to the oil tank flange.

The boiler consists of a shell, a fire tube and a fire cone.

Fire tube 29 is coaxially welded inside the boiler shell and is separated from it by longitudinal partitions 30.

The boiler shell and fire tube have double walls. The spaces between the walls are filled with coolant.

The spaces of the shell and fire tube are interconnected by six pipes.

Inner cavity of the fire tube is actually boiler furnace 1. Welded from one end of the shell is fire cone 4 which is actually the boiler bottom, and a combustion chamber is secured from the other end.

Fire cone 4 with the double walls has ribs 7 on the outside surface intended for better heat emission to the oil.

A branch pipe is welded to the boiler shell bottom for connection with pipeline 25 supplying coolant from the preheater water pump. Outlet of coolant into the engine cooling system is effected through branch pipe 10.

A union is welded into the boiler shell for attachment of fuel preheating pipe 13.

The pipe consists of two coaxial pipes, the inner one being a through pipe. Fuel is brought into the inner pipe and is delivered in the space between the pipes. After passing between the pipes fuel is heated due to heat in the combustion chamber and is fed through a side union to an injector.

Exhaust gases are evacuated from the boiler through branch pipe 18, the lower flange of which is bolted to the vehicle bottom above the preheater access hole. The access hole is closed with a cover. Guide vanes 28 are fitted in the lower part of branch pipe 18 for uniform distribution and better cooling of gases.

Cover 17 (Fig. 20) of the preheater access hole is located under the vehicle bottom, whereas the device for its opening and closing is arranged in the front right corner of the fighting compartment. Cover 17 is mounted on axle 16 that carries handle 8 on its end.

To open the access hole, loosen locknut 2 and turn the cover by means of handle 8.

The combustion chamber is attached to the boiler by means of bolts 9 (Fig. 186). It is actually a perforated housing accommodating injector 17 and glow plug 32.

The chamber inner cavity communicates with fire tube cavity (furnace 1). From the outside the chamber is closed with jacket 11.

Bolted in the combustion chamber is an exhaust gas outlet branch pipe, fresh air supply pipeline 20 with air shutter 16. The air shutter is controlled by a cable linkage; linkage handle 51 (Fig. 6) is located in the driving compartment on the driver's right.

Fuel is supplied to injector 17 (Fig. 186) via pipeline 14 from the preheater fuel cock. The handle of cock 47 (Fig. 6) is arranged on the left side behind the driver on the engine compartment bulkhead.

Preheater injector 17 (Fig. 186) atomizes fuel in the boiler combustion chamber at a pressure of 4 kgf/cm^2. The injector consists of body 12 (Fig. 187), spray tip 14, spring 15, a stop screw and filter 9.

Injector body 12 is screwed into union 1, which is attached by its flange 3 to the preheater boiler flange. Wound on the union outer surface is spiral 6, insulated with an asbestos thread and a special insulating pipe. One end of the spiral is connected with the vehicle mains, and the other is connected to frame ("earth"). Spiral 6 is intended for additional heating of fuel. From the outside the insulation is closed with casing 17. Drilled inside

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[redacted]

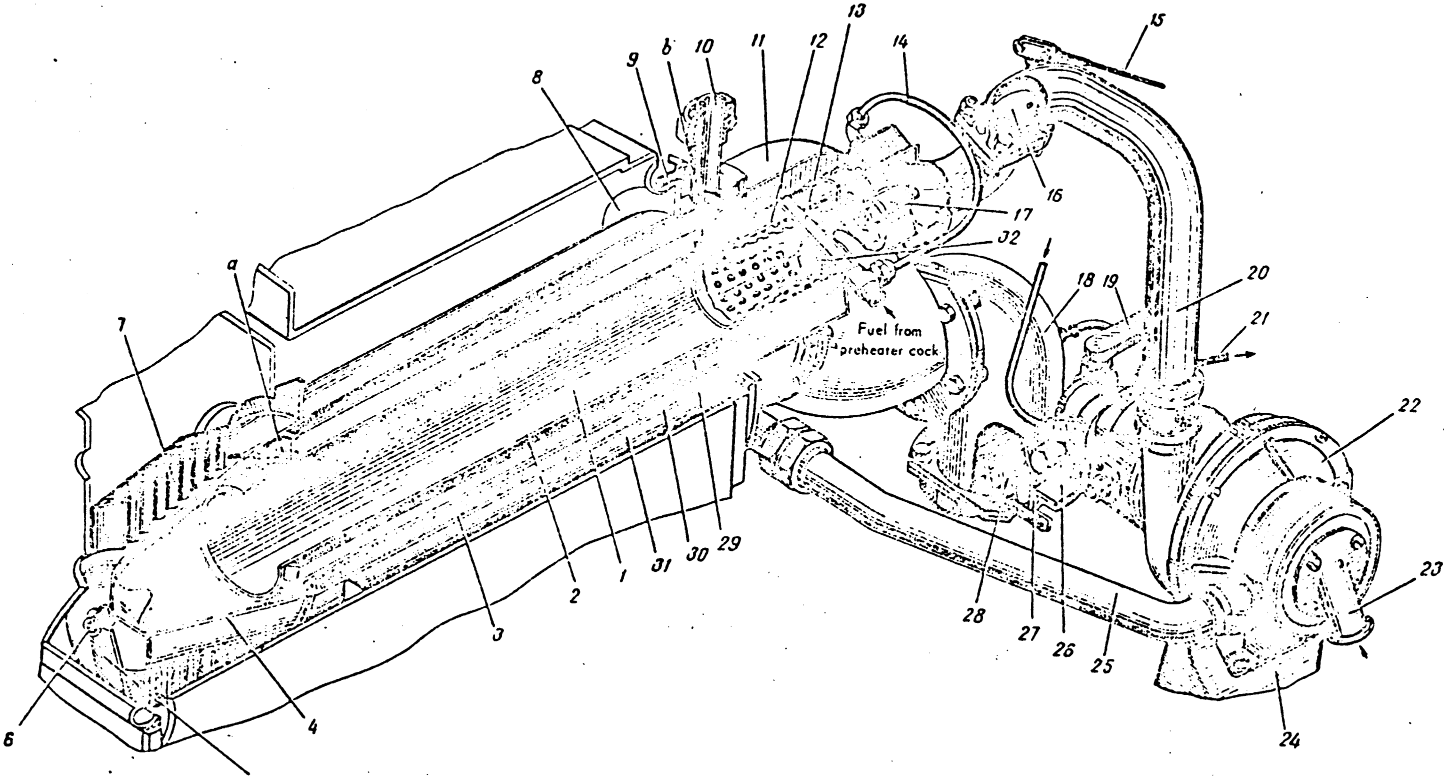

FIG. 156. INJECTOR PREHEATER

1 - boiler furnace; 2 - boiler inner wall; 3 - outer wall; 4 - fire cone; 5 - preheater attaching bracket; 6 - preheater support; 7 - fire cone ribs; 8 - boiler-to-oil tank attaching flange; 9 - boiler attaching bolt; 10 - branch pipe for outlet of hot liquid from boiler to cooling system; 11 - jacket; 12 - burner; 13 - fuel preheating pipe; 14 - injector fuel supply pipeline; 15 - preheater air shutter control cable; 16 - air shutter; 17 - injector; 18 - exhaust gas outlet branch pipe; 19 - handle of exhaust gas outlet port cover; 20 - burner air supply pipeline; 21 - fuel feed system pipeline to preheater cock; 22 - preheater pump unit; 23 - preheater water pump inlet branch pipe; 24 - pump unit attaching bracket; 25 - preheater pump-to-boiler coolant supply pipeline; 26 - flange; 27 - packing; 28 - guide vanes; 29 - fire tube; 30 - longitudinal partition; 31 - boiler shell; 32 - glow plug; a, b - pipes connecting shell cavities with fire tube

[redacted]

union 1 is channel "a" for delivery
set of shaped plates fitted on hexagon rod 16 screwed in screw 10.

Fuel from the preheater pump is fed to union 5, passes through a channel of the injector union and gets in the space around filter 9. Passing between the shaped plates, fuel is cleaned and gets into the longitudinal channels formed by the hole in the plates and therefrom through a drilling in screw 10 and a radial drilling in the spray tip comes into the inner space of spray tip 14. Then fuel is injected under a pressure of 4 kgf/cm^2 through 0.5-mm dia. hole into the combustion chamber. Passing through the radial hole, fuel is swirled in the spray tip cavity to improve atomization.

The glow plug (Fig. 188) is intended to ignite the stream of fuel atomized by the injector when the preheater is started. The plug is turned in the lower threaded hole of the combustion chamber and incorporates body 1, central electrode 4, spiral 3, insulators 5 and 6 and three clamping nuts 7 and 8.

Voltage is supplied to the glow plug from the storage battery through a wire secured by nuts 8 on the end of central electrode 4. The other end of the spiral is connected with the "earth".

The preheater pump unit (Fig. 189) consists of electric motor 4, fuel pump 2, blower 16 and a water pump. The pump unit is mounted on a bracket bolted to the vehicle bottom in the engine compartment.

Preheater electric motor 4, type МБП-34, is a DC separate-excitation machine with power taken off both ends 15 and 18 of the armature shaft.

The gear fuel pump comprises body 28, a pair of gears 1 and 27, connecting coupling 19 and by-pass ball valve 20. The body threaded cylindrical part is screwed into the cover of the electric motor frame. Two unions 21 and 29 are screwed in the body for fuel inlet and outlet.

The by-pass valve is installed in the channel communicating with the pump delivery chamber. In case the pressure exceeds the permissible limits, ball 26 of the valve is pressed off its seat and fuel is returned from the delivery to suction chamber of the pump.

Pump drive gear 1 is driven from electric motor shaft end 18 through connecting coupling 19 screwed on the shaft end.

The centrifugal-type blower is secured to the motor frame cover. It is designed for delivery of air into the boiler combustion chamber. The blower consists of volute-shaped body 5, impeller 7 and protective wire net 10. The body is made integral with the outlet branch pipe.

The body is closed from the rear with cover 8 secured with screws. Blower impeller 7 is secured on electric motor shaft end 15 by means of screws and a bushing.

Air comes to the blower through protective wire net 10, where it is caught by the impeller blades and is thrown by the centrifugal force to the volute periphery, wherefrom it is fed in the combustion chamber through a pipeline.

The centrifugal-type water pump ensures circulation of coolant in the engine cooling system. It consists of cover 12, a body, impeller 11 and packing 14.

The pump body is made integral with blower body cover 8 and outlet branch pipe 13.

Pump impeller 11 is mounted over a key on motor shaft end 15 and is fastened with a nut.

For switching on the electric motor and the glow plug the central panel mounts two switches bearing inscriptions GLOW PLUG (СВЕЧА) and ENGINE PREHEATING (ОБОГРЕВ ДВИГАТ.).

6.7.3. Operation of Preheating System

When the preheater is functioning, the electric motor drives water pump impeller 11, which forces the coolant through the space between the boiler walls, with the hot gases passing inside the boiler. The coolant gets heated and is branched into three flows at the boiler outlet:

- the first flow passes through the jackets of cylinder heads and cylinders and returns to the preheater boiler through the engine water pump and preheater pump;

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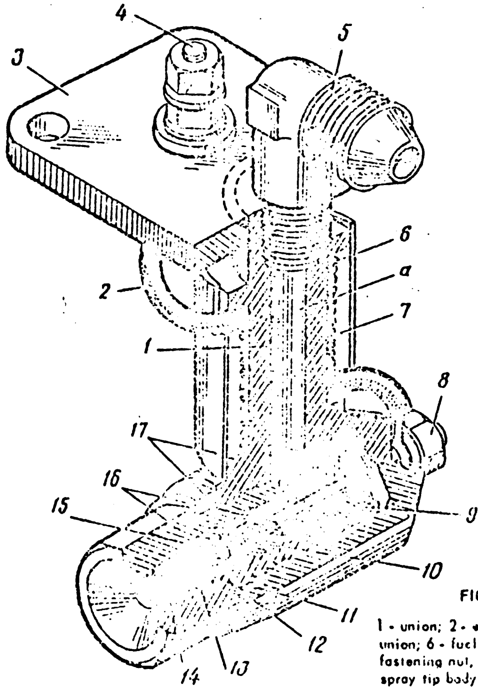

FIG. 187. INJECTOR OF PREHEATER

1 - union; 2 - electric wire; 3 - attaching flange; 4 - bolt; 5 - fuel supply union; 6 - fuel heating spiral; 7 - thermal insulation; 3 - electric wire fastening nut, 9 - filter; 10 - screw; 11 - gasket; 12 - injector body; 13 - spray tip body; 14 - spray tip; 15 - spring; 16 - hexagon rod; 17 - casing; a - channel

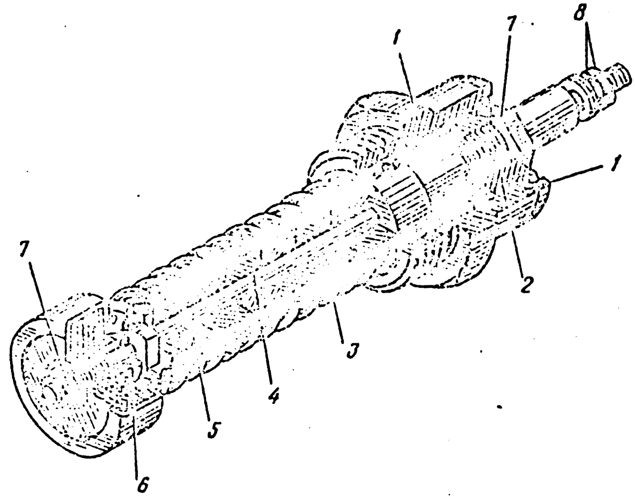

FIG. 188. GLOW PLUG

1 - body of plug; 2 - nut; 3 - spiral; 4 - central electrode; 5 - insulator; 6 - end insulator; 7 - clamp nuts; 8 - electric wire fastening nuts

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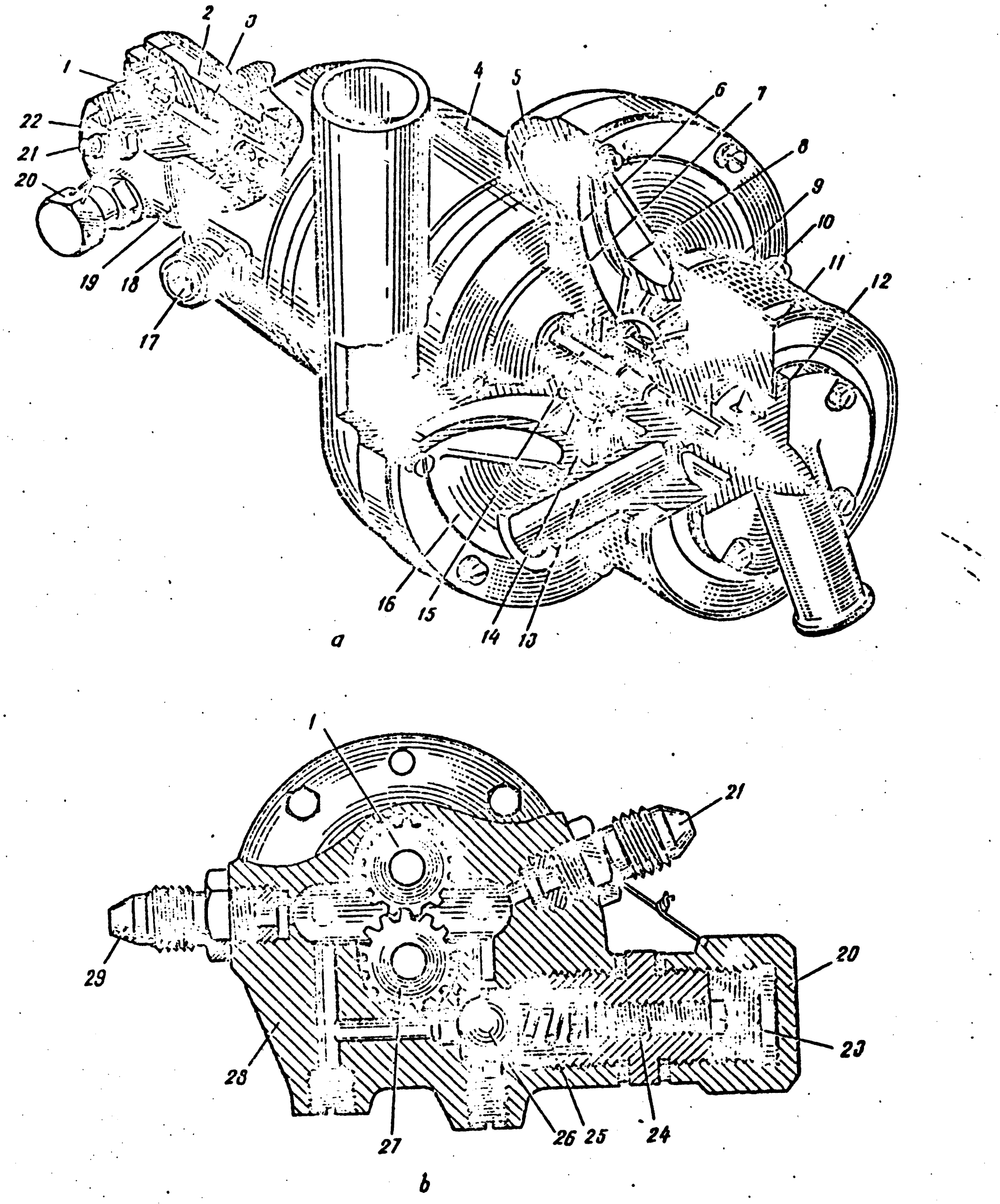
1
2
3
4
5
6
7
8
9
10
11
12
22
21
20
19
18
17
16
15
14
13
a
1
21
29
20
23
28
27
26
25
24
b

FIG.189. PREHEATER PUMP UNIT

a - pump unit; b - fuel pump

1 - fuel pump drive gear; 2 - fuel pump; 3 - packing; 4 - electric motor; 5 - blower body; 6 - blower body fastening nut; 7 - blower impeller; 8 - blower body cover; 9 - packing nut; 10 - wire net; 11 - water pump impeller; 12 - water pump body cover; 13 - water pump outlet branch pipe; 14 - packing; 15, 18 - electric motor shaft ends; 16 - blower; 17 - receptacle of electric motor plug connector; 19 - connecting coupling; 20 - by-pass valve; 21 - inlet union; 22 - fuel pump cover; 23 - nut; 24 - by-pass valve screw; 25 - by-pass valve spring; 26 - valve ball; 27 - driven gear; 28 - fuel pump body; 29 - outlet union

[redacted]

to the boiler through the preheater pump;

- the third flow passes through the cooling system radiator and comes to the preheater boiler through the engine water pump.

6.7.4. Care

Care of the preheater consists in:

- checking the preheating system for proper functioning when preparing the vehicle for operation in winter;
- checking the pipelines and wiring for condition and proper fastening;
- cleaning periodically the system and checking it for proper functioning.

6.8. ENGINE STARTING SYSTEM

6.8.1. Components

For starting the engine, the vehicle is equipped with two systems:

- air starting system (principal one);
- system of starting by means of an electric starter.

Both systems operate independently; in case it is extremely hard to start the engine, both systems may be used simultaneously (combined starting).

6.8.2. Air Starting System

The system (Fig. 190) comprises electropneumatic valve 1, air distributor 4, non-retur valve 3, air pipelines and starting valves 5.

Compressed air is fed to the system from bottle 7 of the pneumatic equipment.

The electropneumatic valve is intended for remote control of the compressed air delive from the air bottle to the air distributor when the engine is started. The valve is actuate by button AIR DELIVERY (ПУСК ВОЗД.) located on the central panel, and in case the electric button fails, the valve can be engaged with a manual lever located on the electropneumatic valve body.

Electropneumatic valve 10 (Fig. 6) is arranged on the vehicle side to the left of the driver.

The design and operating principle of the electropneumatic valve are described in Section 15.

The air distributor (Fig. 191) serves to distribute air to the engine cylinders in acc dance with the engine firing order. The air distributor is installed on the left-hand cylinder block from the flywheel side.

Air distributor body 1 is an aluminium alloy stamping. The body central boring accommodates air distributor shaft 11. The shaft journal is lubricated with oil fed through holes "d".

Drilled around the boring in the body are six ducts "a" and "b", that receive screwed-clamps 2 attaching the pipes for supply of air to the cylinders.

The shaft is joined through adjusting bushing 4 with distributing disc 3 having slide valve port "c". The arc of the slide valve port occupies 60°. Resetting of the adjusting bushing furnished with small inner splines and large outer splines permits to set slide val port "c" in the correct position relative to ducts "b" in the air distributor body and to just the moment of air delivery to a cylinder.

Disc 6 retained with lock ring 9 is installed in the boring of the hub of distributing disc 3. Disc 6 is pressed to nut 7 locked with cotter pin 12. Spring 5 installed between th adjusting bushing and disc 6, presses off the distributing disc and provides a clearance between the air distributor body and distributing disc during the engine operation.

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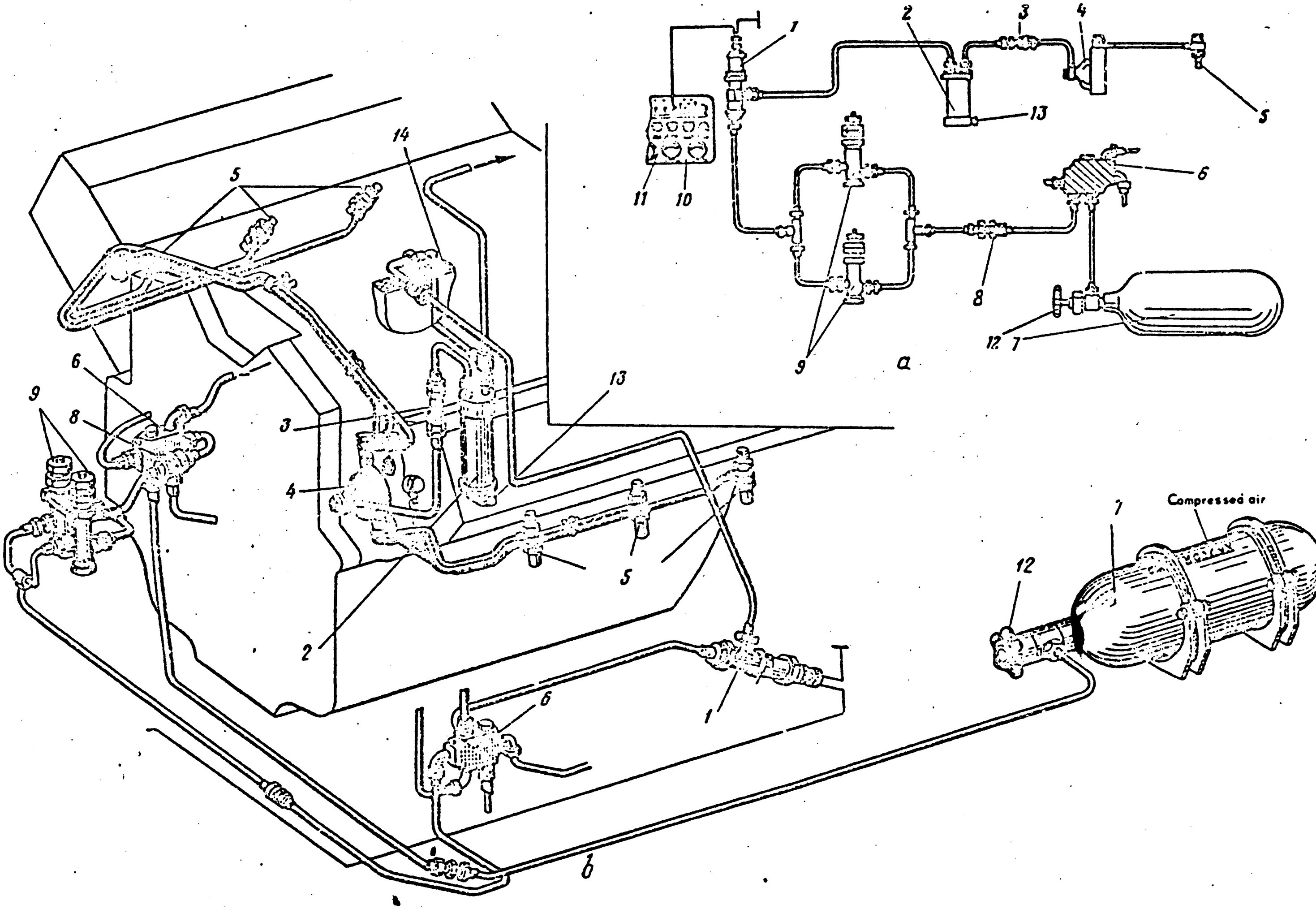
1
2
3
4
5
13
11
10
9
6
8
12
7
a
14
5
13
6
8
9
3
4
2
5
1
6
7
12
Compressed air
b

FIG. 190. ENGINE AIR STARTING SYSTEM

a - diagram; b - general view

1 - electropneumatic valve; 2 - settler; 3 - non-return valve; 4 - air distributor; 5 - starting valve; 6 - distribution box; 7 - air bottle; 8 - felt air filter; 9 - pressure reducers; 10 - central panel; 11 - air start button; 12 - air bottle valve; 13 - oil settler drain plug; 14 - engine compartment bulkhead

When the engine is being started, compressed air comes in the air distributor space and overcoming the force of spring 5, presses the distributing disc to the air distributor body. Herewith, slide valve port "c" gets aligned with one of six ducts "b" in the body. The air that has passed through the body ducts is delivered via a pipe and a starting valve into the cylinder during the expansion stroke and, actuating the piston, makes the crankshaft rotate.

As the crankshaft and, hence, the distributing disc are turned, the slide valve port communicates in turn with each of the cylinders according to their firing order.

The air pressure required for engine starting must be not less than 30 kgf/cm^2. The maximum permissible pressure of air fed to the air distributor is 70 kgf/cm^2.

Starting valve 16 (Fig. 135) is intended for admission of compressed air in the cylinde during starting. The valves are screwed in the cylinder heads under the intake manifolds. A through channel is drilled from each valve seat to the combustion chamber.

The starting valve comprises cylindrical body 2 (Fig. 192) housing disc valve 1 with stem 7, spring 5, a washer, nut 6 and cap 4. The spring constantly presses the valve disc to the seat. Compressed air is delivered to the valves through pipes from the air distributor. The pipeline swivelling union is fitted on the smooth recess of the body with radial holes "a"; the union is packed with copper-asbestos rings 3 and is pressed with cap 4.

Air, coming into the valve space, presses the valve disc and opens passage to the cylinder.

The settler is intended to catch water condensate and drops of oil contained in the air delivered by the compressor. The settler is a hollow cylinder with two unions and drain plug 13 (Fig. 190) for draining of the sediment. The settler is secured to a post on the engine compartment bulkhead.

The air starting system operates as follows. When air bottle valve 12 is opened, air is fed to distribution box 6, passes felt filter 8 and comes to pressure reducers 9, where the pressure is reduced down to 70 kgf/cm^2.

When electropneumatic valve 1 is cut in, compressed air goes through settler 2 and non-return valve 3 to air distributor 4. From the air distributor depending on the position of th distributing disc air is fed to one or two engine cylinders and, pressing the piston, turns the crankshaft and together with it the distributing disc, which directs air to all cylinders in turn, bringing the crankshaft to the speed required for starting (100 - 150 rpm).

Care of the air starting system consists in:

- draining sediment from the settler;
- checking the system for leakage and air bottle for proper pressure;
- checking the air bottle inspection date and presenting the bottle for inspection (once every 5 years);
- checking and, if necessary, adjustment of the air distributor.

Checking and adjustment of air distributor is performed in case abnormal functioning is detected or after repair of the air distributor. For checking and adjustment do the following

(a) raise the front ribbed plate;

(b) remove the bolts securing cover 29 (Fig. 8) of the engine clutch access hole and remove the cover;

(c) remove the bolts securing the casing above index 7 (Fig. 133) and remove the casing;

(d) secure the engine cranking device on the engine clutch access hole by means of bolts;

(e) uncotter and unscrew union 13 (Fig. 191) of the air distributor air supply pipe and disconnect the latter;

(f) unscrew cap 8 of the air distributor;

(g) rotating the crankshaft forward (counterclockwise, as viewed from the flywheel side) set the piston of the third left-hand cylinder at 18±2° after TDC in the working stroke (in-

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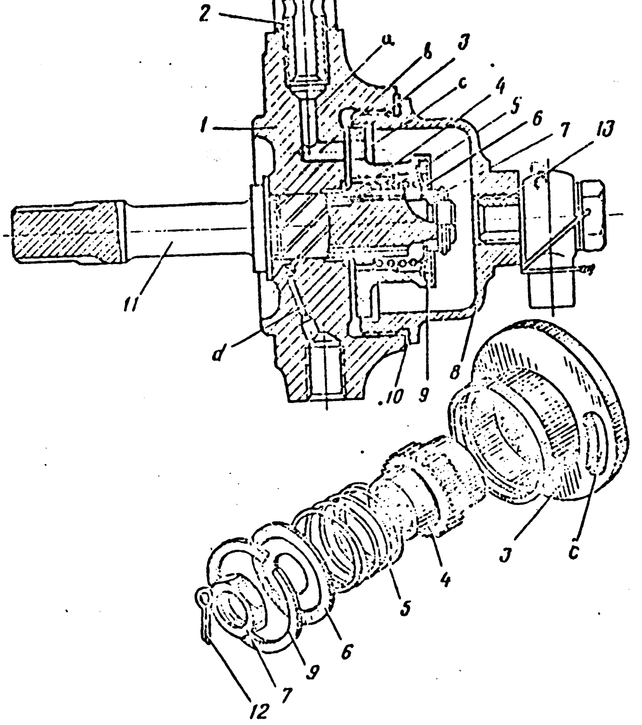

FIG. 191. AIR DISTRIBUTOR

1 - air distributor body; 2 - clamp; 3 - distributing disc; 4 - adjusting bushing; 5 - spring; 6 - disc; 7 - nut; 8 - cap; 9 - lock ring; 10 - gasket; 11 - shaft; 12 - cotter pin; 13 - air supply union for air supply from air starting system; a, b - ducts for supply of compressed air to cylinders; c - slide valve port; d - lubricant supply hole

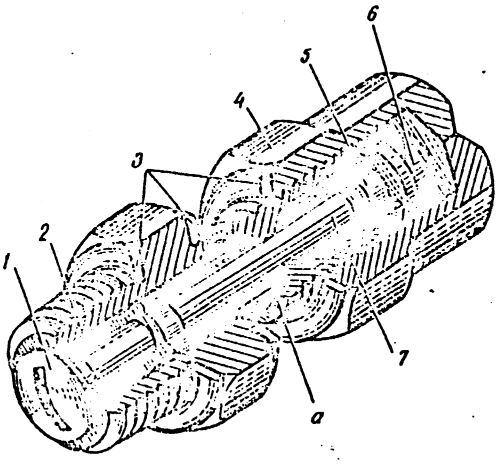

FIG. 192. STARTING VALVE

1 - starting valve; 2 - body; 3 - packing rings; 4 - cap; 5 - spring; 6 - nut; 7 - valve stem; a - radial hole

[redacted]

[redacted]

the on-coming (front, as viewed in the direction of forward motion) edge of the oval hole o distributing disc 3 must align with the edge of this hole.

If the edges do not align, adjust the air distributor as follows:

(h) uncotter and unscrew nut 7, remove distributing disc 3 and spring 5;

(i) successively rearranging adjusting bushing 4 on the splines of shaft 11 and selecting the position of the distributing disc, align the edges of the holes. Mark the position of the distributing disc relative to the body of the air distributor, and remove the disc;

(j) reinstall spring 5, distributing disc 3 and screw on nut 7;

(k) turn the crankshaft backward by 20 - 30° and then rotating the crankshaft forward, set the third left-hand cylinder piston at 18±2° after TDC in the working stroke;

(l) after the adjustment is accomplished, cotter the nut and reinstall cap 8;

(m) connect the air supply pipe and lock it with wire;

(n) remove the cranking device;

(o) reinstall the casing, engine clutch access hole cover and the front ribbed plate o the hull.

6.8.3. Engine Starting by Means of Starter

The engine is started by means of the starter, when the engine air starting system is faulty.

Electric starter 10 (Fig. 133) is mounted in the lower portion of the cylinder block-and-crankcase unit; the starter gear is engaged with the rim of flywheel 1.

For the description of the electric starter, see Section 9.

6.9. ENGINE WATER PROTECTION MECHANISM

6.9.1. Purpose and Design

The engine protection mechanism (Fig. 193) serves to prevent penetration of water insi the engine through the intake manifolds during negotiation of water obstacles.

The mechanism consists of two valve boxes 6 and 13, disc valves 5, valve 10, ejector 9 to evacuate gases from the engine compartment, and valve control linkage.

When the engine stops, valves 5 and valve 10 automatically stop passage of water into the exhaust manifolds, and through gas suction ejector 9 into the engine compartment.

To prevent penetration of water into the intake manifolds through the dust suction ejector and air cleaner, provision is made for valve 5 (Fig. 170) which closes as the splash pa nel and air intake pipe rise.

The protection mechanism may be actuated through one of two control linkages: automati electric or manual mechanical.

The electric control linkage consists of valve control mechanism 4 (Fig. 193) includin lock 6 (Fig. 194), rod 7 connected through cables 22 with valves 11, electromagnet (ЭМС-3) 25, limit switch 30 in the electromagnet circuit, and relay РКД mounted in relay box КР-40 of the protection system.

The manual control linkage includes handle 1 with eccentric, rod with spring 3 connected through cable 4 with the rod, and roller 5.

The driver's central panel has signal lamp 26 VALVE (КЛАПАН). Before entering the wate prepare the engine protection system for use, for which purpose place control linkage handle 1 in the upper position, and close switch 27 AFLOAT (ПЛАВ.) on the central panel; besides, the valve of the air cleaner dust suction ejector closes at the moment the splash panel rises.

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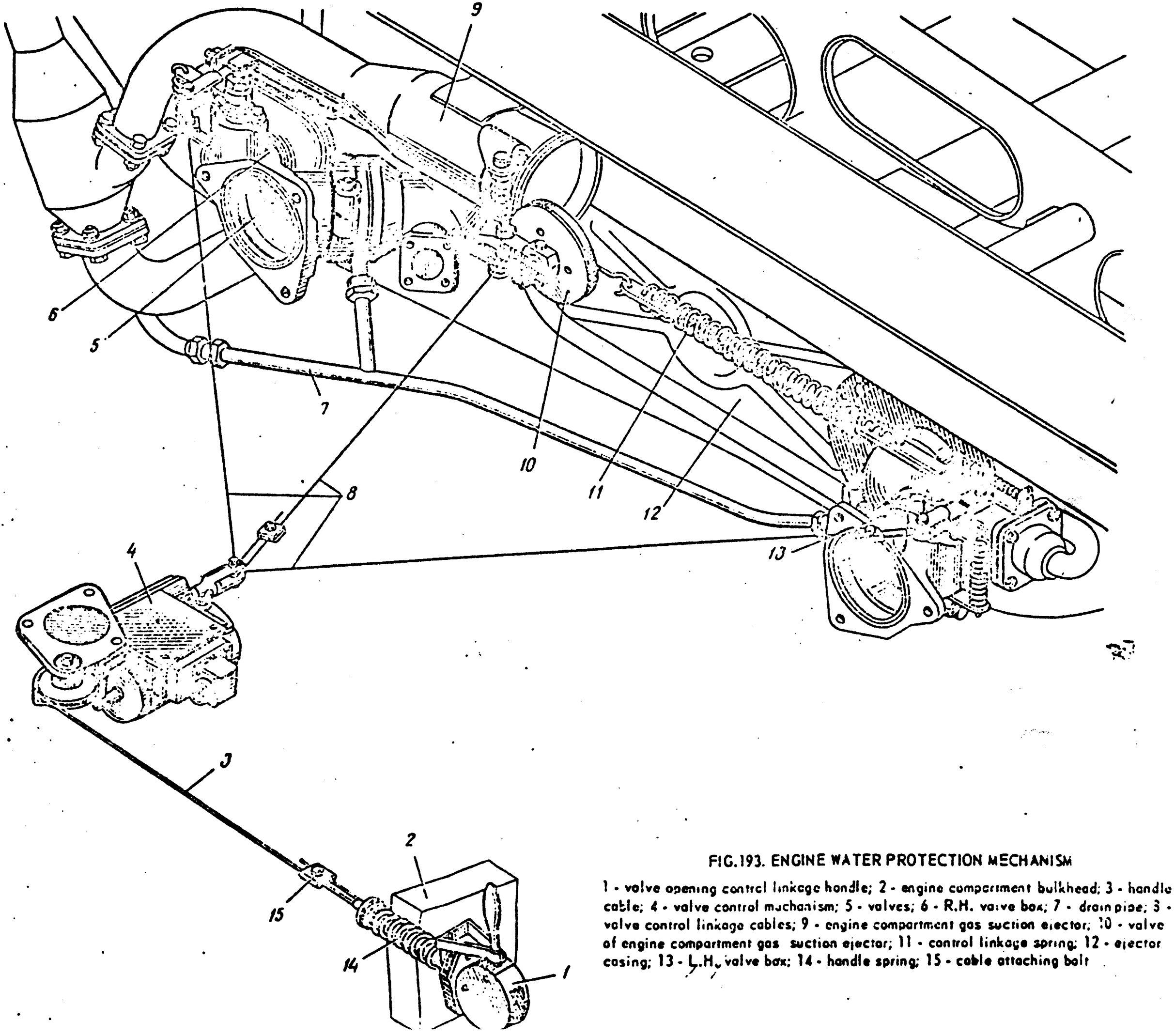

FIG.193. ENGINE WATER PROTECTION MECHANISM

1 - valve opening control linkage handle; 2 - engine compartment bulkhead; 3 - handle cable; 4 - valve control mechanism; 5 - valves; 6 - R.H. valve box; 7 - drainpipe; 8 - valve control linkage cables; 9 - engine compartment gas suction ejector; 10 - valve of engine compartment gas suction ejector; 11 - control linkage spring; 12 - ejector casing; 13 - L.H. valve box; 14 - handle spring; 15 - cable attaching bolt

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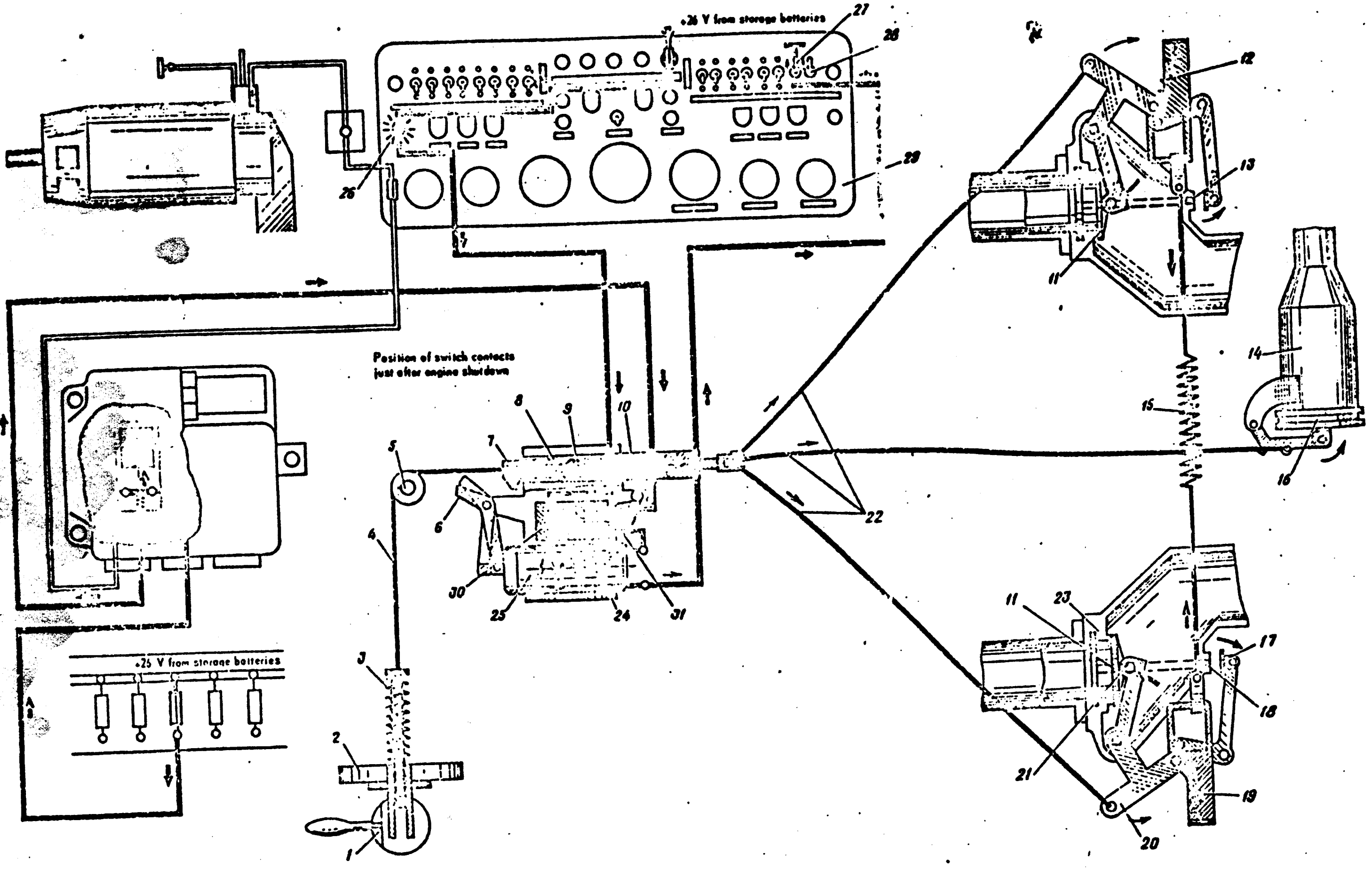
+26 V from storage batteries
27
28
29
26
12
13
11
14
15
16
22
Position of switch contacts just after engine shutdown
5
8
9
10
7
6
30
25
24
31
4
3
2
1
+26 V from storage batteries
11
23
17
18
21
19
20

FIG.194. OPERATION DIAGRAM OF ENGINE WATER PROTECTION MECHANISM

1 - valve control linkage handle; 2 - engine compartment bulkhead; 3 - spring; 4 - control linkage cable; 5 - roller; 6 - lock; 7 - rod with teeth; 8 - change-over contacts; 9 - block; 10 - lever of limit switches; 11 - valve; 12 - valve spring; 13 - water drain valve; 14 - engine compartment dust suction ejector; 15 - spring of cable device; 16 - ejector valve; 17 - drain valve; 18 - water drain valve; 19 - lever; 20 - three-arm lever; 21 - valve axle; 22 - cables; 23 - valve box; 24 - winding of electromagnet; 25 - electromagnet (ЭЛС-3); 26 - signal lamp VALVE (КЛАПАН); 27 - switch AFLOAT (ПЛАВ); 28 - storage battery switch; 29 - control panel; 30 - limit switch; 31 - electromagnet rod

[redacted]

[redacted]

with the engine running, relay РХД (relay of the engine protection valves), whose winding is connected to the vehicle generator, is energized, and its contacts open the circuit of electromagnet 25.

As the engine stops, the generator also stops, and the relay winding gets deenergized. The contacts close, and the winding of electromagnet 25 is supplied through switch AFLOAT.

The electromagnet draws in the core and the latter pulls the arm of lock (latch) 6. The latch releases the tooth of rod 31, and the valves close under the action of springs 15. Rod 31 displaces lever 10 and opens limit switch 30, thus breaking the electromagnet circuit. As a result, signal lamp 26 VALVE lights up.

As valves 11 close, levers 20 turn and actuate drain valves 17 (located in the valve boxes) and open them, thus draining water from the engine manifolds.

To place the valves in an initial position, manually turn handle 1 down. Switch AFLOAT must be open. As a result, cable 4 pulls rod 7 which opens valves 11 through three cables 22 and closes drain valves 17. Lock (latch) 6 engages the tooth of rod 7 and fixes it. Contacts 8 of limit switch 30 open, and signal lamp 26 goes out.

6.9.3. Care of Engine Protection Mechanism

Care of the engine protection mechanism includes checking of the engine protection valves, electric wires and cables for condition and checking of the cables for proper tension.

Check and adjust the valve control cables as required whenever abnormal operation is detected and every 4500 - 5000 km of run. Do it as follows:

(a) unscrew the securing bolts of the above engine access hatch cover and open the latter;

(b) open the engine protection valves, for which purpose place handle 5 (Fig. 15) in the lower position;

(c) check the tension of the engine valve control cables; sagging of the cables under their own weight is not allowed. When a finger effort is applied to the middle of the cables, their deflection should be about 20 mm.

If the tension is not as required, adjust it as follows:

(d) close the engine protection valves, for which purpose turn handle 32 (Fig. 6) upward;

(e) unscrew bolt 15 (Fig. 193) coupling the securing straps of cable 3;

(f) tighten the cable and clamp the straps, for which purpose screw in bolt 15; displacement of the straps relative to each other is not allowed;

(g) open the engine protection valves and check the cable tension once again;

(h) close the access hatch above the engine.

CAUTION. After the tension of the cables is checked and adjusted, the engine protection valves must be open; handle 5 (Fig. 15) must be in the lower position.

6.10. Power Plant Troubles and Remedies

Trouble	Cause	Remedy
Engine fails to start	Air in fuel system	Prime fuel system with pump ВЦН
	Engine speed at start too low:	
	- insufficient air pressure in bottle	Start engine by electric starter and charge bottle

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Trouble	Cause	
	- air starting pipeline joints untight	Detect fault by ear and visually and eliminate it
	- storage batteries discharged	Check state of storage batteries and charge them, if necessary
Engine stalls immediately after start	Fuel cock closed	Open cock
	Fuel tanks empty	Fill fuel tanks
	Fuel pipeline clogged (in winter time formation of ice locks in pipeline and coarse filter is possible)	Check fuel pipeline and fuel filter (if locks are formed, heat pipeline and filter. Do not use open flame for the purpose)
Oil pressure gauge does not indicate sufficient pressure	Insufficient amount of oil in tank (gauge pointer fluctuates)	Replenish tank
	Pressure gauge faulty	Check and, if necessary, replace pressure gauge
	Pressure reducing valve clogged	Wash valve
Blow-by of exhaust gases	Manifold flange nuts loose	Tighten up nuts
Oil is diluted with fuel (oil consumption decreases sharply)	High-pressure pipe unions untight on injectors	Tighten up high-pressure pipe unions
	Injector spray tip needle jammed	Check and replace faulty injector
Cooling liquid leaks between water pump and cylinder block-and-crankcase unit or through level hole of water pump	Packing between water pump and cylinder block-and-crankcase unit faulty	Tighten up packing flange nuts. If trouble persists, remove water pump and replace rubber sealing ring
	Water pump end packing faulty	Remove water pump and replace faulty parts
Engine fails to develop sufficient power	Fuel feed control linkage out of adjustment	Adjust fuel feed control linkage
	Air intake pipe screen clogged	Clean screen
	One or several injectors faulty	Disconnect injectors in succession to detect faulty injectors. Replace faulty injectors
	Fuel injection pump faulty. Plunger or follower jammed, spring broken	Set fuel injection pump lever 43 (Fig. 156) at maximum feed and successively disconnect high-pressure pipes. As engine is cranked by compressed air or starter, no fuel i fed from faulty sections. S faulty pump for repair
	Fuel injection advance angle out of adjustment	Check and adjust fuel inj tion advance angle according to entry in Certificate
	Fuel filters dirty	Wash fuel filters

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#2

7. POWER TRANSMISSION

7.1. PURPOSE AND COMPONENTS

The power transmission (Fig. 195) is designed to:

- transmit a torque from the engine crankshaft to the driving sprockets;
- change the speed of movement and the traction forces on the tracks;
- steer and brake the vehicle, to move it back and hold on upgrades and downgrades;
- disconnect the engine from the driving sprockets both for a short and long time.

The power transmission consists of engine clutch 1, gearbox 27, two planetary steerin gears 28 and two final drives 29.

7.2. ENGINE CLUTCH

7.2.1. Design

The engine clutch is of a double-disc dry friction type. The engine clutch serves to connect the engine from the gearbox for a short time, to smoothly place the vehicle in mot and to protect the units of the power transmission from breakdowns when the load on the sprockets sharply increases.

The engine clutch is arranged together with the gearbox in a common housing and separated from the latter by an inner partition.

The engine clutch consists of driving members, driven members and release mechanism.

The driving members are rigidly connected with the crankshaft. The driving members ar support disc 19 (Fig. 195) fitted in the recess of the flywheel, driving drum 17 having in ternal teeth, and casing 14 fastened by common bolts 18 to the engine flywheel. The teeth the driving drum are engaged with the teeth of driving disc 20 and pressure plate 22. Casing 14 incorporates nine sleeves 24 which hold two concentric spiral pressure springs 16 each.

Support disc 19 has a hub having internal splines for engagement with oil pump drive shaft 7.

The driven members of the engine clutch are: two steel discs 21 (glued to both sides the latter are friction discs made from special friction material КФ-2, GOST 1786-57), ha ing internal teeth, and driven drum 23 bearing driven discs on its teeth.

The driven drum is spline-connected with hollow shaft 25 made as a single unit with driving bevel gear of the gearbox.

The clutch release mechanism consists of booster 9 with piston 10, housing 13 with r dial-thrust bearing, three back-moving springs 5, three double-arm levers 1 fitted on ax inside casing 14.

7.2.2. Engine Clutch Control

The engine clutch hydraulic control is combined with the power transmission hydrauli control.

The control system consists of pedal 3 (Fig.197) secured on the shaft of pedal bridg resting on two double-row ball bearings, lever 5 fitted on the other end of the shaft, co trol rod 6 connecting lever 5 with lever 9, upper bridge 8 secured on gearbox 20 and join

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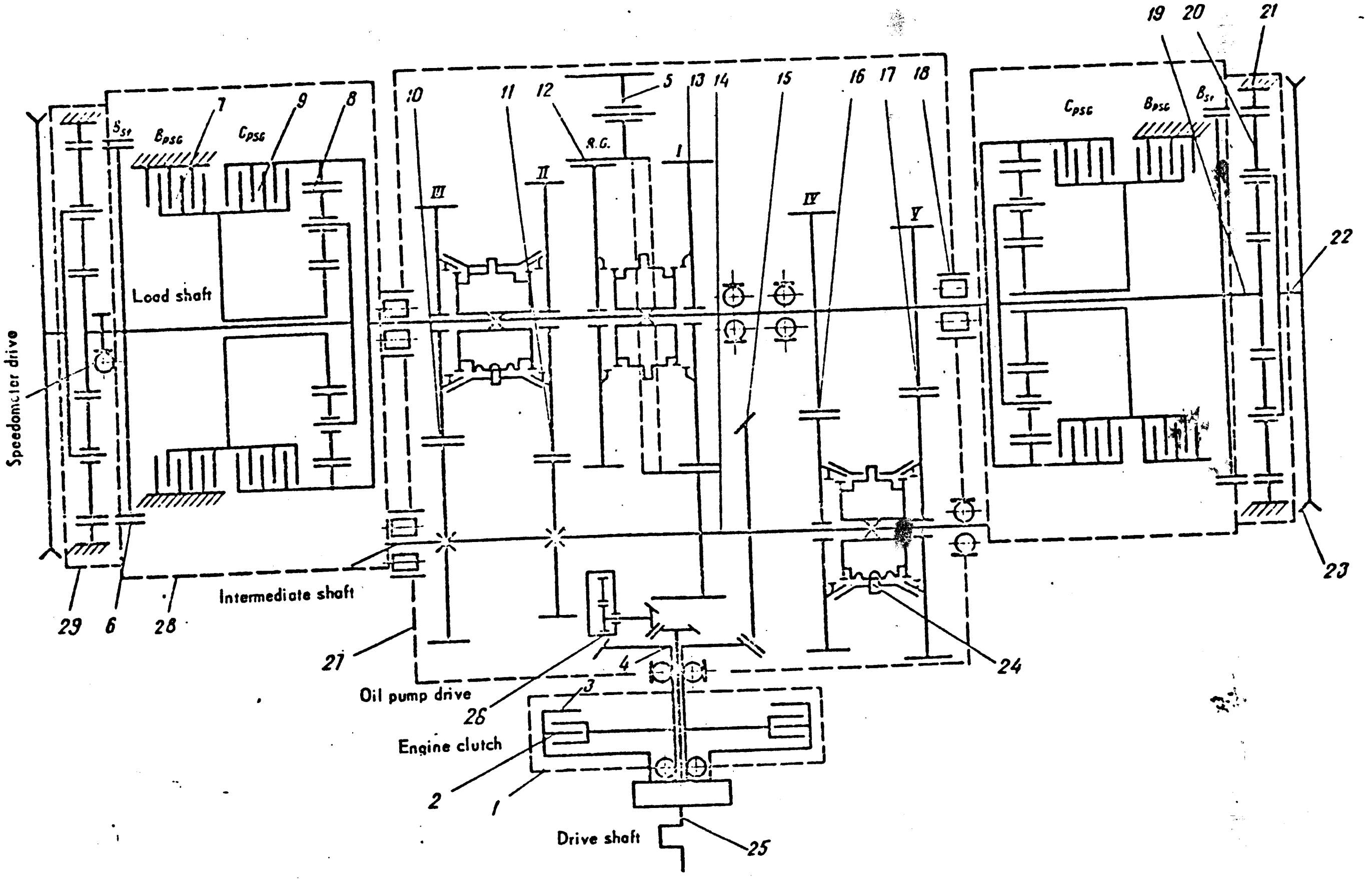
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B_{PSG}
C_{PSG}
R.G.
I
II
III
IV
V
Load shaft
Speedometer drive
Intermediate shaft
Oil pump drive
Engine clutch
Drive shaft

FIG. 195. POWER TRANSMISSION GEARING

1 - engine clutch; 2 - engine clutch discs; 3 - oil pump drive shaft; 4 - drive shaft with bevel gear; 5 - intermediate reverse gear; 6 - stopping brake; 7 - disc brake of planetary steering gear; 8 - planetary gear set of steering gear; 9 - blocking clutch; 10 - 3rd speed gear; 11 - 2nd speed gear; 12 - reverse gear; 13 - 1st speed gear; 14 - driven shaft; 15 - driven bevel gear; 16 - 4th speed gears; 17 - 5th speed gears; 18 - load shaft bearing; 19 - final drive shaft; 20 - planet pinion; 21 - final drive housing; 22 - final drive carrier shaft; 23 - driving sprocket; 24 - synchronizer; 25 - engine crankshaft nose; 26 - oil pump; 27 - gearbox; 28 - planetary steering gears; 29 - final drives

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in the seat, the slide valve admits oil into booster 9 (Fig.196) or cuts off the oil supply.

Smooth engagement of the engine clutch is ensured by special valve 14 (Fig.197) consisting of valve proper 25, spring 23, gauze filter 24 and adjusting washers 22. The smooth engagement valve is secured on the gearbox beside the valve box.

Engine clutch pedal 3 is held in the initial position by spring 2.

Apart from the hydraulic control, provision is made for a pneumatic control which is used when the engine is inoperative or when the hydraulic control fails.

7.2.3. Operation of Engine Clutch and Its Hydraulic Control

In the initial position when engine clutch pedal 3 is released, slide valve 33 stops oil supply to the main channel, piston 10 (Fig.196) is brought away from the double-arm levers by springs 5 and under the action of pressure springs 16 the driven discs and the driving disc are held together, i.e. the engine clutch is engaged.

When the vehicle moves, the engine clutch transmits the torque from the engine to the gearbox due to the friction forces between the discs. When the resistance to movement rises and the transmitted torque exceeds the friction forces, the discs slip, thus protecting the parts of the engine and power transmission from overload.

Pressing engine clutch pedal 3 (Fig.197) turns lever 5 which moves control rod 6, lever 9, control rod 10 and displaces slide valve 33 through lever 12; as a result, the slide valve admits oil into engine clutch booster 46 (Fig.198). The oil causes piston 50 to move and press the housing of radial thrust bearing 51 and turn release mechanism levers 48 which pull pressure plate 44 and thus compress springs 45.

Friction discs 52 move apart, and the engine clutch is released.

To smoothly engage the engine clutch, while placing the vehicle in motion, first of all release the pedal to half of its travel and keep in this position for a short time until it is evident that the discs are compressed (the engine speed decreases and the vehicle starts to move). While moving, slide valve 33 opens duct "b" leading to smooth engagement valve 14, and oil is drained from the booster through throttle hole "c" of the smooth engagement valve.

With pedal 3 in this position, main drain channel "d" is closed by slide valve 33, and oil escapes from the booster either by pressing off spring 29 through the ball of valve 30 or through throttle hole "c". Delayed oil draining ensures smooth approach of friction discs 52, i.e. smooth engagement of the engine clutch.

When shifting in gears (when the smooth engagement valve is not used), release the pedal quickly. In this case oil drains from the booster not only through smooth engagement valve 14, but also through drain hole "d" having a large cross-sectional area. As a result, the engine clutch is engaged quickly.

7.2.4. Design and Operation of Pneumatic Control

The engine clutch release pneumatic control consists of cock 45 (Fig.308), non-return valve 49 (Fig. 198) and pipelines. It also includes valve 33, ducts of the valve box and engine clutch booster.

For the design and operation of the control, see Section 15.

To release the engine clutch, depress engine clutch pedal 3 all the way down, and then pull handle 45 (Fig.308) of the cock located in front and to the left of the driver.

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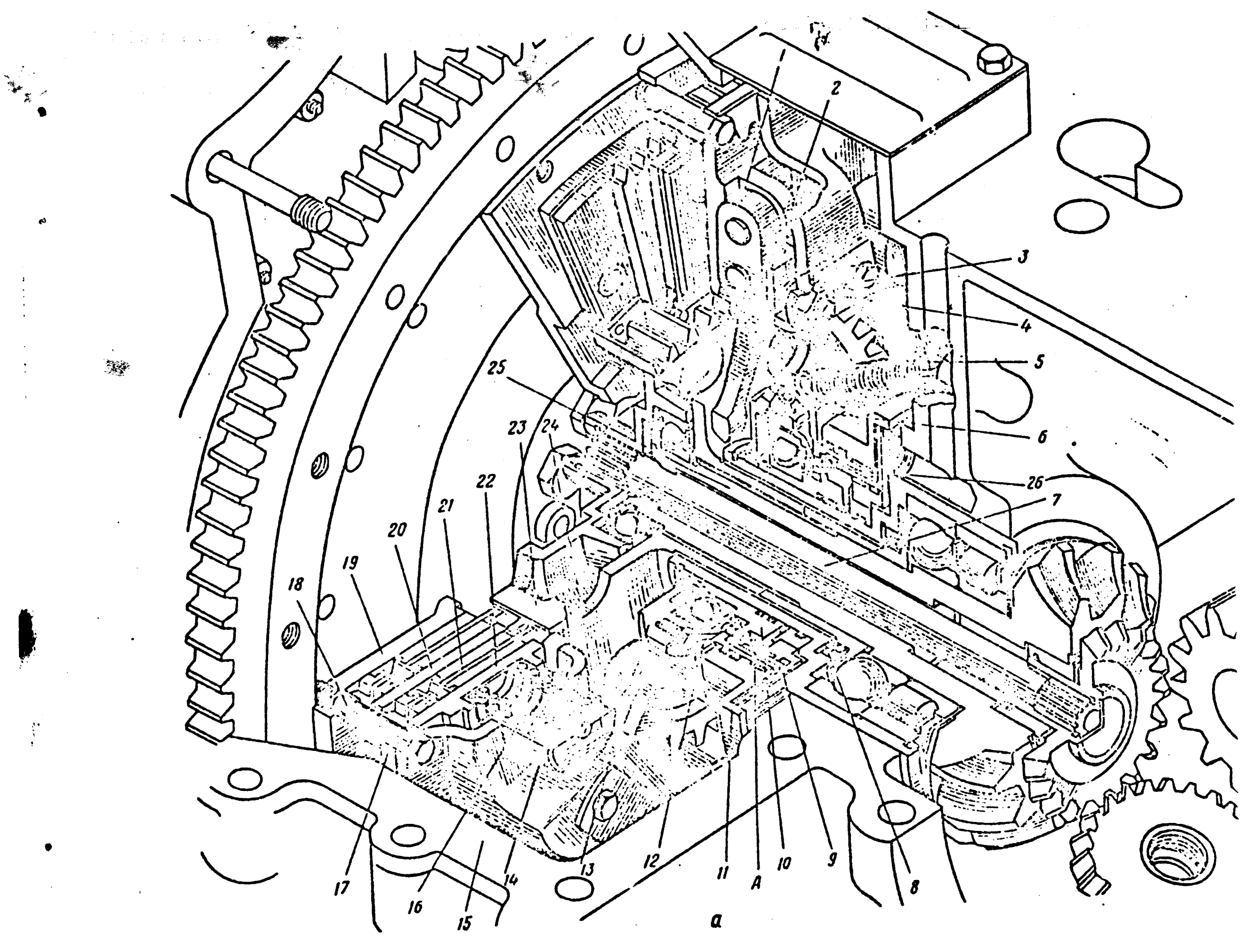

FIG.196. ENGINE CLUTCH

a - general view; b - section; 1 - double-arm lever; 2 - fork; 3 - adjusting nut; 4 - locking pl
5 - back-moving spring; 6 - lubrication hole plug; 7 - gearbox oil pump drive shaft; 8 - sprin
loaded oil seal; 9 - engine clutch booster; 10 - booster piston; 11 - packing body; 12 - bear
13 - housing of clutch release mechanism bearing; 14 - engine clutch casing; 15 - gear cas
16 - pressure spring; 17 - driving drum; 18 - bolt; 19 - support disc; 20 - driving friction dis
21 - driven friction discs; 22 - pressure plate; 23 - driven drum; 24 - spring sleeve; 25 - ge
box drive shaft; 26 - piston stroke limiter ring; A - cavity

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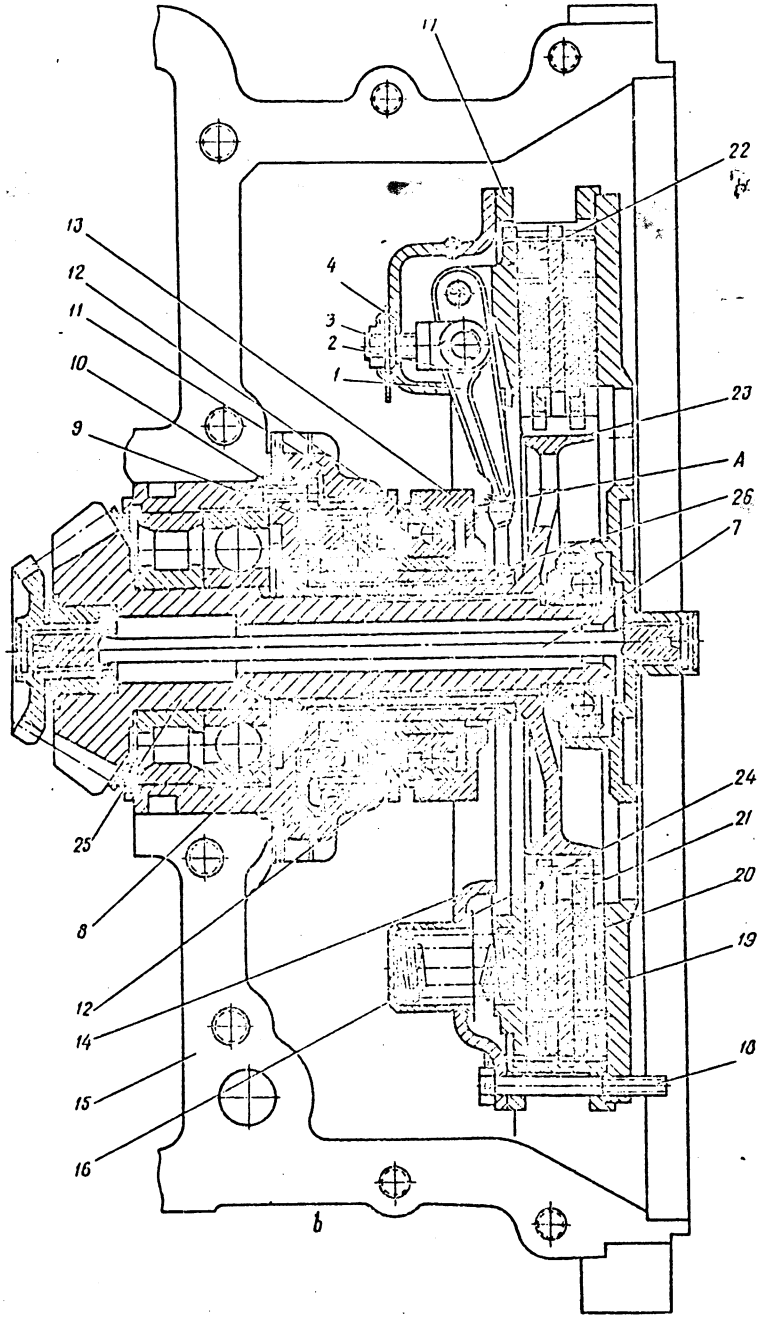
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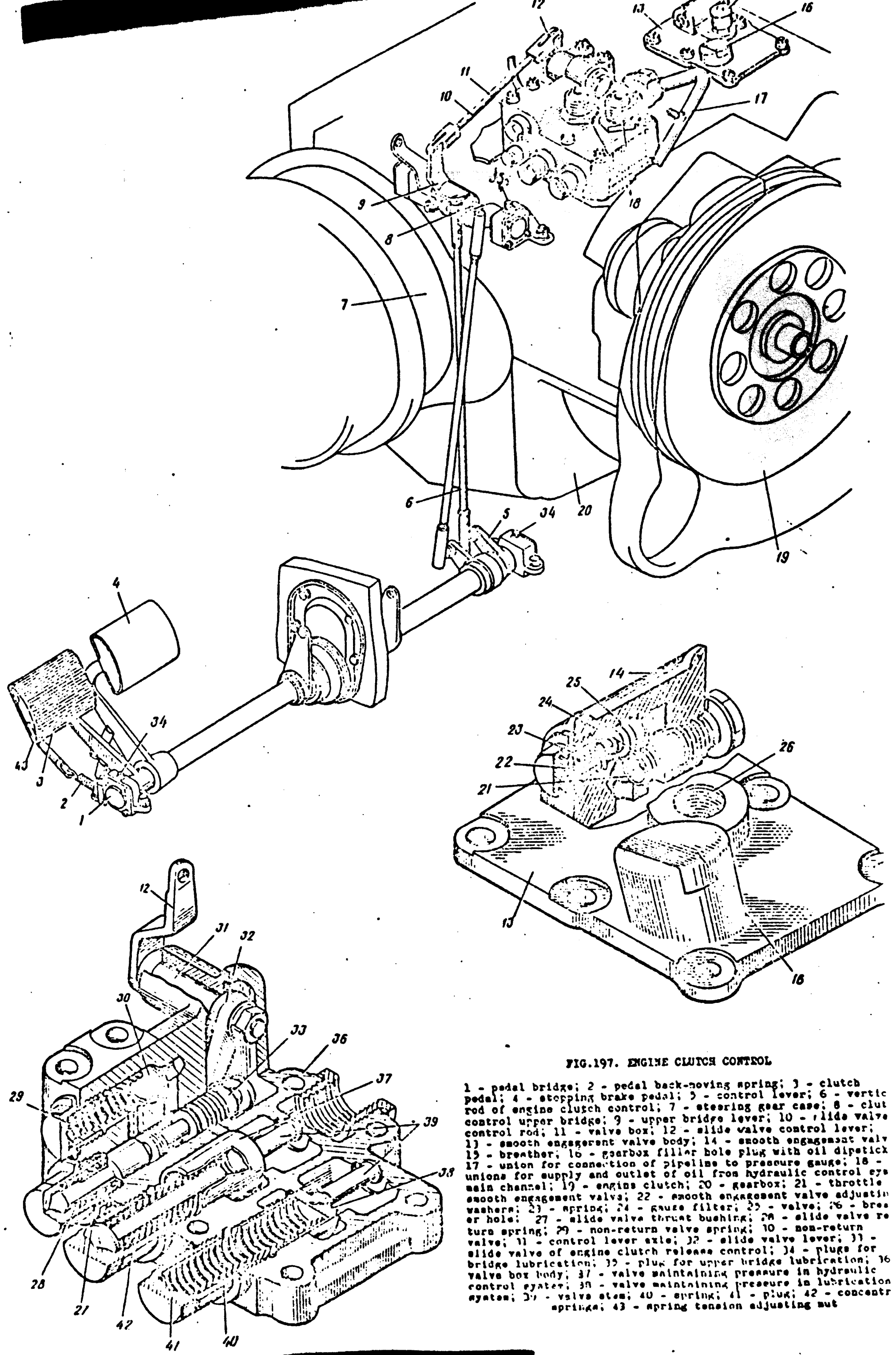

FIG.197. ENGINE CLUTCH CONTROL

1 - pedal bridge; 2 - pedal back-moving spring; 3 - clutch pedal; 4 - stopping brake pedal; 5 - control lever; 6 - vertic rod of engine clutch control; 7 - steering gear case; 8 - clut control upper bridge; 9 - upper bridge lever; 10 - slide valve control rod; 11 - valve box; 12 - slide valve control lever; 13 - smooth engagement valve body; 14 - smooth engagement valv 15 - breather; 16 - gearbox filler hole plug with oil dipstick 17 - union for connection of pipeline to pressure gauge; 18 - unions for supply and outlet of oil from hydraulic control sys main channel; 19 - engine clutch; 20 - gearbox; 21 - throttle smooth engagement valve; 22 - smooth engagement valve adjustin washers; 23 - spring; 24 - gauze filter; 25 - valve; 26 - bree er hole; 27 - slide valve thrust bushing; 28 - slide valve re turn spring; 29 - non-return valve spring; 30 - non-return valve; 31 - control lever axle; 32 - slide valve lever; 33 - slide valve of engine clutch release control; 34 - plugs for bridge lubrication; 35 - plug for upper bridge lubrication; 36 valve box body; 37 - valve maintaining pressure in hydraulic control system; 38 - valve maintaining pressure in lubrication system; 39 - valve stem; 40 - spring; 41 - plug; 42 - concentr springs; 43 - spring tension adjusting nut

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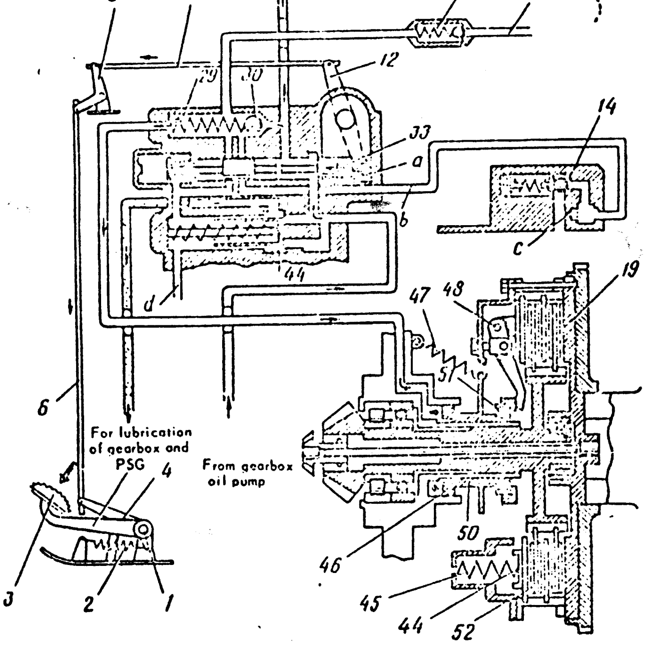

FIG. 198. ENGINE CLUTCH HYDRAULIC CONTROL SYSTEM OPERATION DIAGRAM

(For Ref. Nos refer to Fig. 197.)

44 - pressure plate; 45 - pressure springs; 46 - engine clutch booster; 47 - back-moving spring; 48 - release mechanism lever; 49 - ball non-return valve; 50 - booster piston; 51 - radial thrust ball bearing; 52 - friction discs; a - duct; b - duct to smooth engagement valve; c - throttle hole; d - main drain channel

7.2.5. Care of Engine Clutch and Its Control

Care of the engine clutch includes:

- regular checking of the engine clutch for proper adjustment;
- lubrication of the engine clutch release mechanism bearing;
- checking of the control rods and hinge joints for proper state, attachment and locking;
- lubrication of the control bridges.

7.2.6. Checking and Adjusting the Engine Clutch

Check the engine clutch every 2400-2500 km of run. Adjust the engine clutch as required.

Perform the check and adjustment as follows:

(a) unscrew the bolts and raise the front ribbed plate of the hull;

(b) unscrew the securing bolts of engine clutch housing access hole cover 29 (Fig.8) and take off the latter;

(c) check the clearance between bearing housing 13 (Fig.196) and double-arm lever 1. A 4-mm feeler gauge (kept in the SPTA set) should go;

(d) revolve the driving members of the engine clutch by means of the cranking device or special jimmy to a position at which it is possible to check the clearance between the second and third double-arm levers and bearing housing. Check the clearance. If the feeler gauge does not go, proceed with adjustment as follows:

(e) uncotter the bolts of lock plate 4, unscrew them and remove the plate;

(f) adjust the clearance between bearing housing 13 and levers 1 by means of adjusting nuts 3 so that a 7-mm feeler gauge does not go and 6.7-mm feeler gauge goes;

(g) mount lock plate 4, screw in the bolts and cotter them;

(h) close the access holes.

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7.2.7. Packing Grease into
Release Mechanism

Perform the operation every 4800-5000 km of run, as follows:

(a) raise the ribbed plate of the hull;

(b) open engine clutch access hole cover 29 (Fig.8);

(c) manually turn bearing housing 13 (Fig.196) until the lubrication fitting faces up;

(d) connect the hose of the plunger-type grease gun with the lubrication fitting of the engine clutch bearing;

(e) pack about 60 g of grease into the bearing as indicated by the grease gun stem;

(f) disconnect the grease gun hose from the lubrication fitting and stow the grease gun;

(g) reinstall the access hole covers.

7.2.8. Packing Grease into Bearings of Engine Clutch Control Bridges

Pack grease into the bearings every 8000-9000 km of run. Do it as follows:

(a) raise the front ribbed plate;

(b) unscrew one plug 34 (Fig. 197) for lubrication of the bearings of the engine clutch control bridge;

(c) open access hole 15 (Fig.15) in the engine compartment bulkhead to provide an access to the hydraulic vortex tube and unscrew second plug 34 for lubrication of the bridge bearings (under the hydraulic vortex tube);

(d) unscrew two plugs 34 for lubrication of the bearings of the upper engine clutch control bridge (on top of the gearbox);

(e) screw the lubrication fitting of the grease gun into one of the holes and pack grease;

(f) pack grease into the other bearings of the bridges in the same manner;

(g) unscrew the lubrication fitting of the grease gun;

(h) screw in the lubricating plugs;

(i) close the access hole covers.

7.3. GEARBOX

7.3.1. Design

The gearbox (Fig.199) is combined with two planetary steering gears. It serves to change the traction force and the speed of movement, to move the vehicle back and disengage the engine from the driving sprockets for a long time.

The gearbox is of a mechanical, multistage type with permanently-meshed gears. It has five forward gears and one reverse gear.

The gearbox consists of case 1, drive shaft 25 (Fig.196), driven shaft 14 (Fig.199) and load shaft 10 with gears fitted on them, shaft supports and seals, driving bevel gear 17, synchronizers and intermediate reverse gear 5 (Fig.200).

The gear case is cast of aluminium alloy; it consists of lower half 19 and upper half 1 interconnected by bolts 20. The case walls have seats to hold the shaft supports. The lower half mounts oil pump 14 driven by gear 9.

Oil is delivered from the case to the oil pump through gauze filter 16. Attached to the bottom of the lower half of the gear case is thin-walled pan 21 and cover 22 forming spaces for delivery of the heated coolant from the preheating system of the engine; this is necessary to heat the oil and oil pump at low ambient air temperatures. Mounted on top of the gear case are slide valve box 31 (Fig.8) and valve box 30, breather 4 (Fig.200) connecting the inner space of the gear case with the atmosphere, dipstick 6 for indicating the oil level and the engine clutch smooth engagement valve.

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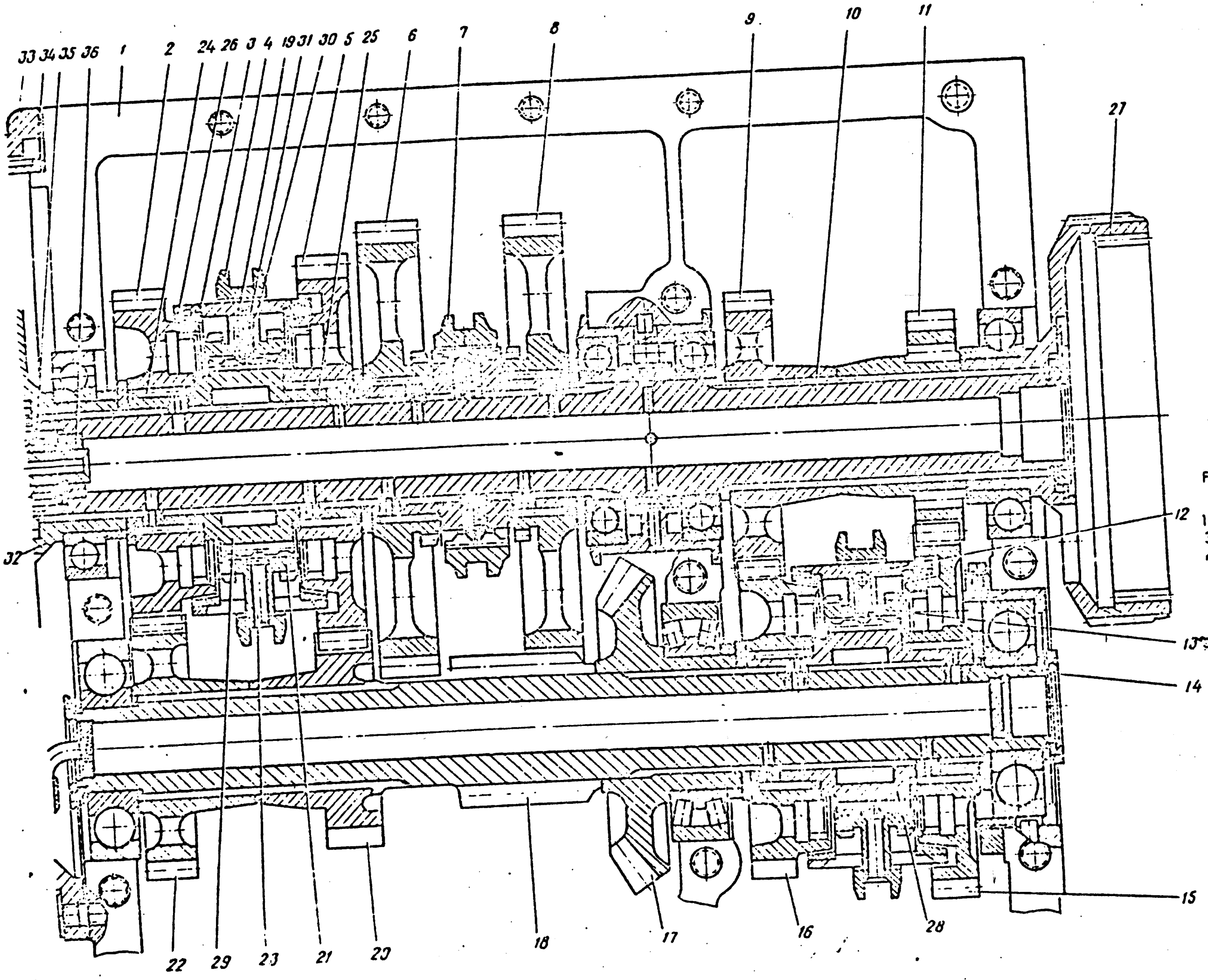
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FIG.199. GEARBOX (LONGITU
SECTION)

1 - gear case; 2 - 3rd speed driv
3 - synchronizer body; 4 - sync
ring; 5 - 2nd speed driven gear;
driven gear; 7 - 1st and revers
toothed coupling; 8 - 1st speed
gear; 9 - 4th speed driven gear;
shaft; 11 - 5th speed driven ge
body of 4th and 5th speed gea
nizer; 13 - toothed coupling; 1
shaft; 15 - 5th speed driving
4th speed driving gear; 17 - g
driving bevel gear; 18 - 1st c
speed driving gear; 19 - reta
synchronizer; 20 - 2nd speed
gear; 21 - 2nd and 3rd speed
coupling; 22 - 3rd speed driv
23 - synchronizer pin; 24 - n
ing, 25 - gear wheel, 26 - sy
cone; 27 - epicyclic gear of
steering gear; 28, 29 - gear
30 - retainer ball; 31 - retai
epicycle; 33 - gear case of
steering gear; 34 - gasket;
36 - bushing

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The gearbox is filled with oil through the dipstick hole.

Drive shaft 25 (Fig.196) is hollow,made integral with the drive bevel gear. The other end of the shaft is splined; it mounts driven drum 23 of the engine clutch. The drive shaft revolves in one roller and two ball bearings. The drive shaft houses oil pump drive shaft 7. The splines of shaft 7 are meshed with the splines of support disc 19, thus providing transmission of torque to the oil pump, with the engine clutch released.

Intermediate driven shaft 14 (Fig.199) revolves in two ball bearings and one double-row roller bearing. It is made integral with 1st and reverse speed driving gear 18. Spline-fitted on one end of the shaft are 2nd speed driving gear 20 and 3rd speed driving gear 22; spline-fitted on the other end of the shaft is gear wheel 25. The finished ends of the gear wheel hub mount needle bearings holding 4th speed driving gear 16 and 5th speed driving gear 15. The middle toothed portion of the coupling bears a synchronizer.

Load shaft 10 is hollow. It revolves in four ball bearings. Spline-fitted on one end of the shaft are 5th speed driven gear 11 and 4th speed driven gear 9. Spline-fitted on the other end of the shaft is gear wheel 25. The finished ends of the gear wheel hub mount needle bearings 24 mounting 3rd speed driven gear 2 and 2nd speed driven gear 5 (free fit).

The splined middle portion of the load shaft bears gear wheel 29; the hub of the latter mounts needle bearings holding 1st speed driven gear and reverse driven gear 6. The middle portion of gear wheel 25 bears the parts of 2nd and 3rd speed synchronizer.

Reverse intermediate gear 5 (Fig.200) is secured on axle 18 revolving in two ball bearings. Gear 5 provides load shaft rotation in a reverse direction. It is meshed with gear 18 (Fig.199) and gear 6.

Gear shifting is performed by means of couplings; 1st and reverse speed coupling 7 has no synchronizer(device designed to facilitate the gear shifting), while the 2nd and 3rd, 4th and 5th speed couplings have synchronizers.

The 1st and reverse speed coupling assembly consists of gear wheel 29, coupling 7 and two retainers 19. It slides with its internal teeth over the external teeth of gear wheel 29 under the action of the fork fitting in the outer groove of the coupling. A groove milled on the inner surface of the coupling receives the end of the sleeve of retainer 19 which is pressed by a spring.

For shifting the gears, move the coupling towards the gear to be engaged. As a result, coupling teeth engage the teeth provided on the gear hub and connect the driving gear with the load shaft.

The 2nd, 3rd, 4th and 5th speed couplings are provided with inertia-type synchronizers.

The synchronizers serve for easier and noiseless gear shifting by synchronizing the rotation speed of the engaged gears with that of the load shaft gears.

The gear shifting coupling provided with a synchronizer consists of gear wheel 29, coupling 21,synchronizer body 3, synchronizer ring 4, pins 23 and retainers 19.

Gear wheel 29 is fitted on the splines of the load shaft; its two teeth arranged at an angle of 180° have three recesses to receive retainers 19 of coupling 21. Coupling 21 is fitted on gear wheel 29 with its internal teeth; its two outer gear rims are meshed with the internal teeth of the hubs of the gears to be shifted. The cylindrical collar of the coupling has twelve channels to hold eight retainers and four pins 23. Synchronizer body 3 fitted on the coupling is fitted with retainers 19; two of the retainers serve also as the retainers of the coupling.

These retainers consist of two sleeves (or ball and sleeve) expanded by spring 31. The inner retainer engages the teeth of gear wheel 25 and thus locks coupling 21 in any operating position or in the neutral position. The outer retainer as well as the other six retainers enter the circular groove of synchronizer body 3 thus locking it in the neutral position. Six of the eight retainers have outer locking sleeves only.

Synchronizer body 3 has on its inner surface two cones 26; riveted to the latter are two bronze taper rings which have grooves for removing lubricant from the taper surfaces. The cylindrical surface of the synchronizer body has four shaped holes for pins 23 to pass.

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shanks pass through the shaped ports of the synchronizer body and enter the holes of ring 4 mounted on the synchronizer body. Synchronizer ring 4 has a groove holding blocks and gear shift forks.

The synchronizer operates as follows. In a neutral position, synchronizer body 3 is fixed with eight retainers relative to coupling 21 and the latter is fixed with two retainers relative to gear wheel 25. Coupling 21 is rigidly connected with the load shaft and revolves at a speed corresponding to the speed of vehicle movement.

When a higher gear is shifted, its speed is higher than that of coupling 21, and when a lower gear is engaged, its speed is lower.

During gear shifting the gear shift fork turns and its blocks actuate synchronizer ring 4. Ring 4 shifts coupling 21 through pins 23, and the motion is transmitted to synchronizer body 3 through the retainers.

While moving in the direction of the gear to be engaged, the coupling depresses the retainer sleeves in their seats and continues to move until the cone of the synchronizer comes to touch the cone of the gear to be engaged. As the coupling and the gear rotate at different speeds, friction force appears between the rubbing surfaces of the cones; this force begins to equalize the speeds and the synchronizer body actuated by the engaged gear turns relative to the coupling until the shaped ports of the synchronizer body thrust with its surfaces against the pins.

In this position the pins are pressed to the surfaces of the ports and do not let the synchronizer body move till the speeds are equalized. As soon as the speeds are equalized, the force pressing the pins to the surfaces of the shaped ports disappears and the pins shift coupling 21 towards the gear to be engaged under the action of the force applied to the gear shift fork. The coupling is fixed in the engaged position by two retainers.

7.3.2. Gearbox Control System

The gearbox control system (Fig.201) consists of a mechanical linkage and hydraulic servomechanism.

The 1st and reverse speed gear is shifted mechanically without the use of the servomechanism.

The control linkage includes gear shift lever 13 mounted in control column housing 23, shaft 20, shifter shaft box 17, control rods 2,3, and 4, servocylinders 5 and 7, lever 6 and three gear shift forks arranged inside the gearbox.

The gear shift lever is secured on axle 19 and fitted with its fork 24 into the slots of shaft 20. The lever axle is secured in frame 22 which is free to rock on its trunnions in the seats of control column housing 23 and therefore shaft 20 may move axially and turn.

Gear choice lever 33 secured on the lower end of shaft 20 enters the slots of couplings 37 of shifter shafts 26, 27 and 28. The shifter shafts are connected with control rods 2, 3 and 4 through ball joints. The 2nd, 3rd, 4th and 5th gear control rods displace the slide valves located in servocylinders 5 and 7.

The servocylinders (Fig.202) consist of body 2, piston 4, slide valve 6 and spring 7. The slide valve shank is connected with the control rod through joint 14. The oil pressure displaces piston 4, coupling 3, turns the fork and the latter shifts synchronizer ring 4 (Fig.199).

1st and reverse speed gear control rod 4 (Fig.201) is hinge-joined by means of a pin with lever 6 fitted on the splines of the respective fork shaft.

The shifter shaft box incorporates ball lock 29 which excludes simultaneous displacement of two shafts and consequently simultaneous engagement of two gears. The lock consists of five balls and lockpins 32. The lock functions as follows: as one of the shifter shafts

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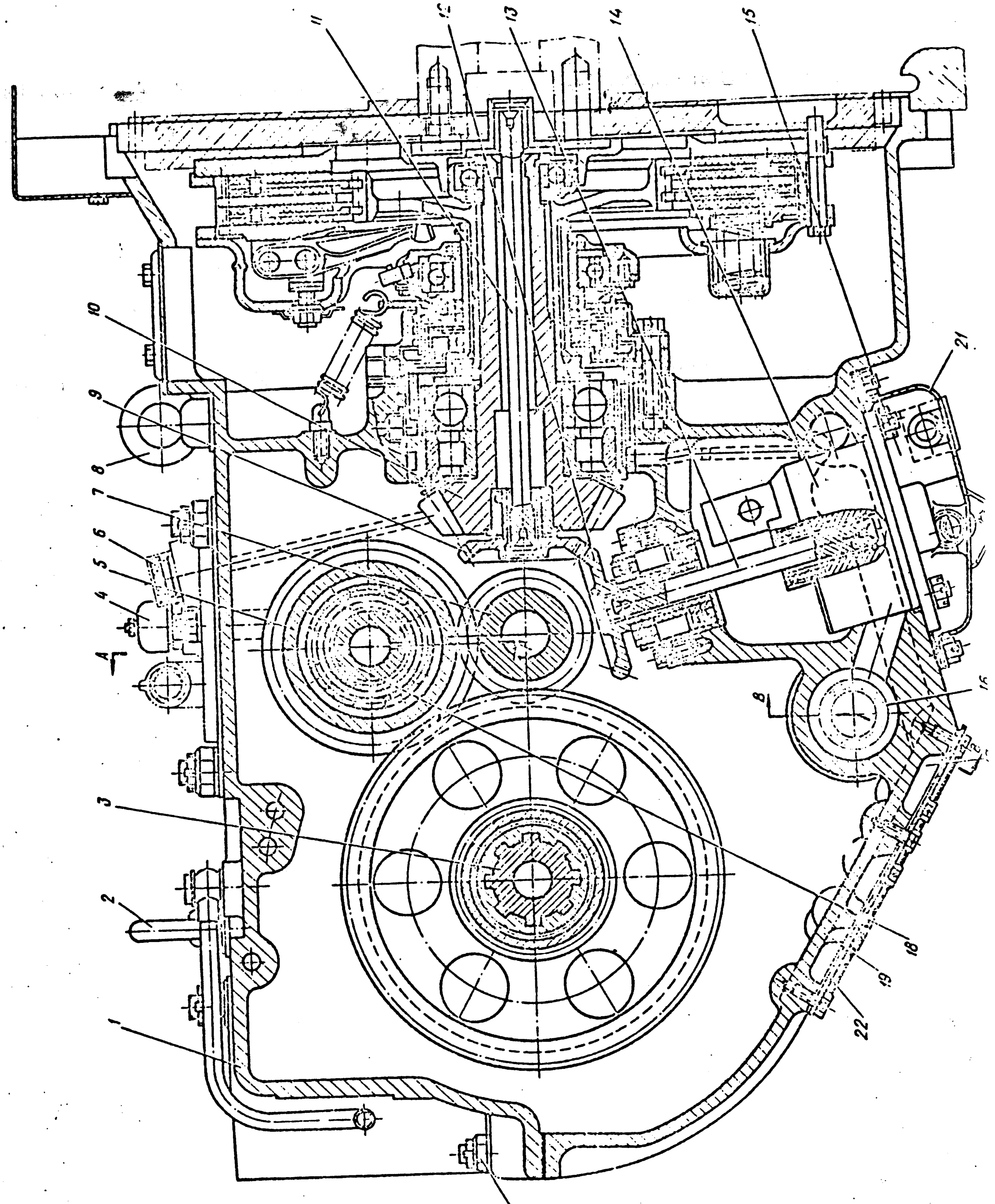
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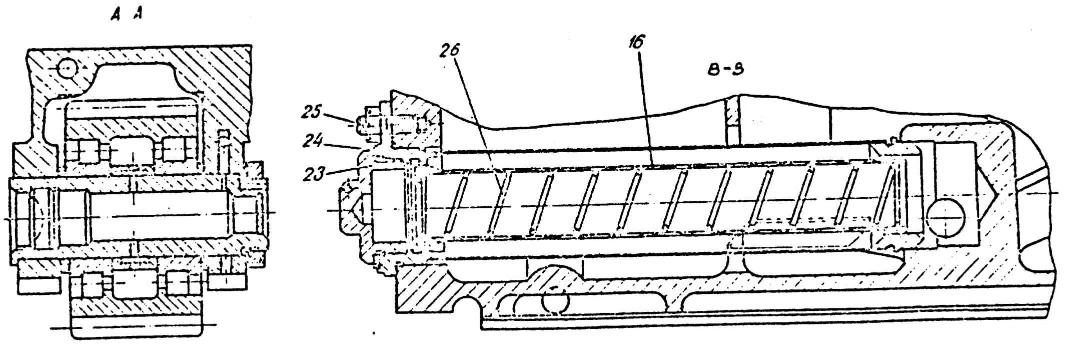

FIG.200. GEARBOX (CROSS SECTION)

1 - gear case upper half; 2 - eye-bolt; 3 - load shaft; 4 - breather; 5 - intermediate reverse gear; 6 - oil dipstick; 7 - driven shaft; 8 - eye-bolt; 9 - oil pump drive gear; 10 - gearbox driving bevel gear; 11 - oil pump driving shaft; 12 - oil pump driven gear; 13 - driven shaft; 14 - oil pump; 15 - heating space of gearbox oil pump; 16 - gauze filter; 17 - gearbox heating space; 18 - intermediate reverse gear axle; 19 - gear case lower half; 20 - bolt; 21 - pan; 22 - cover; 23 - filter plug; 24 - gasket; 25 - nut; 26 - spring

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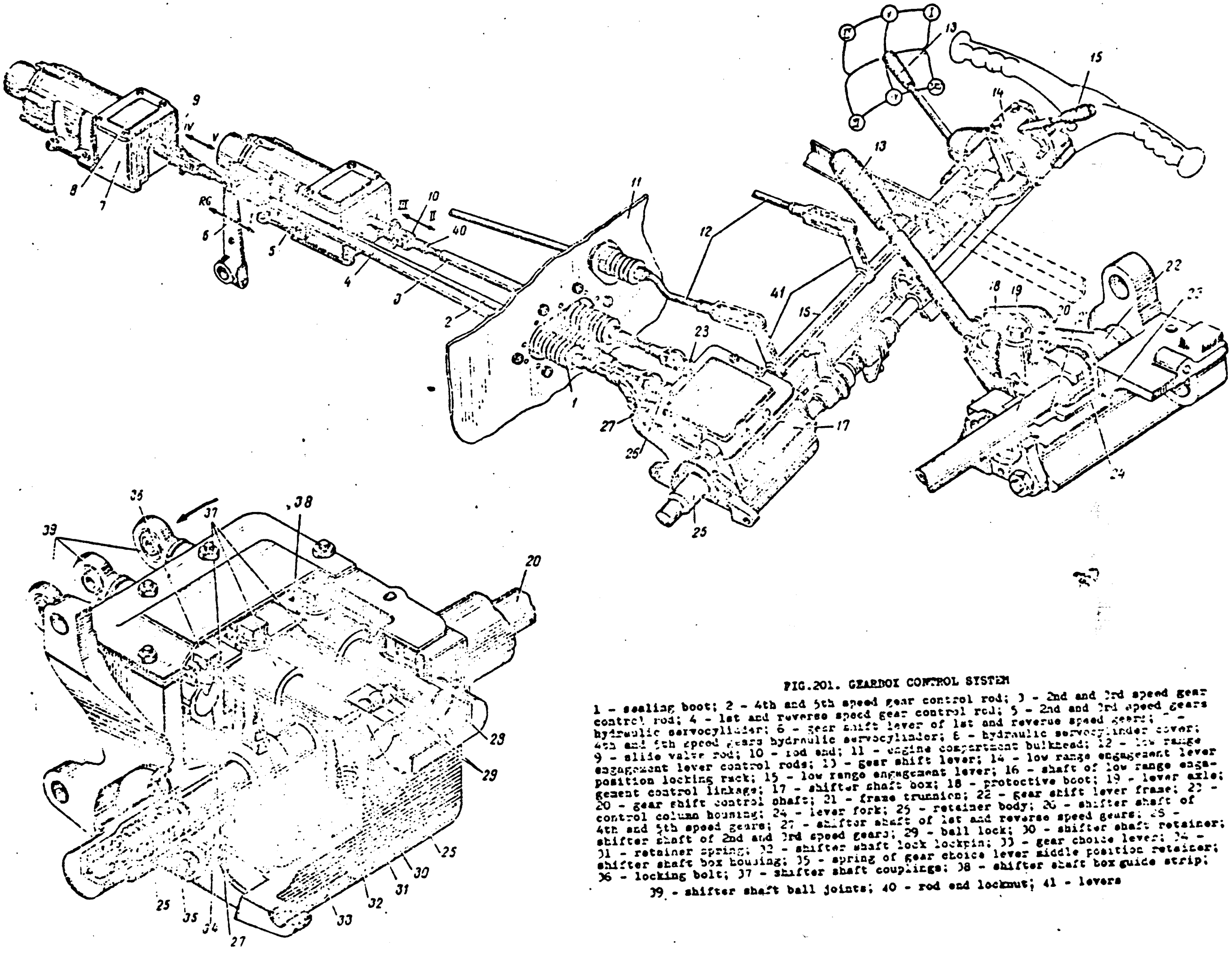

FIG.201. GEARBOX CONTROL SYSTEM

1 - sealing boot; 2 - 4th and 5th speed gear control rod; 3 - 2nd and 3rd speed gear control rod; 4 - 1st and reverse speed gear control rod; 5 - 2nd and 3rd speed gears hydraulic servocylinder; 6 - gear shift lever of 1st and reverse speed gears; 7 - 4th and 5th speed gears hydraulic servocylinder; 8 - hydraulic servocylinder cover; 9 - slide valve rod; 10 - rod end; 11 - engine compartment bulkhead; 12 - low range engagement lever control rods; 13 - gear shift lever; 14 - low range engagement lever position locking rack; 15 - low range engagement lever; 16 - shaft of low range engagement control linkage; 17 - shifter shaft box; 18 - protective boot; 19 - lever axle; 20 - gear shift control shaft; 21 - frame trunnion; 22 - gear shift lever frame; 23 - control column housing; 24 - lever fork; 25 - retainer body; 26 - shifter shaft of 4th and 5th speed gears; 27 - shifter shaft of 1st and reverse speed gears; 28 - shifter shaft of 2nd and 3rd speed gears; 29 - ball lock; 30 - shifter shaft retainer; 31 - retainer spring; 32 - shifter shaft lock lockpin; 33 - gear choice lever; 34 - shifter shaft box housing; 35 - spring of gear choice lever middle position retainer; 36 - locking bolt; 37 - shifter shaft couplings; 38 - shifter shaft box guide strip; 39 - shifter shaft ball joints; 40 - rod end locknut; 41 - levers

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moves out, the ball leaves its recess and displaces the neighbouring balls, thus forcing the extreme balls into the recesses of the other shafts and fixing them.

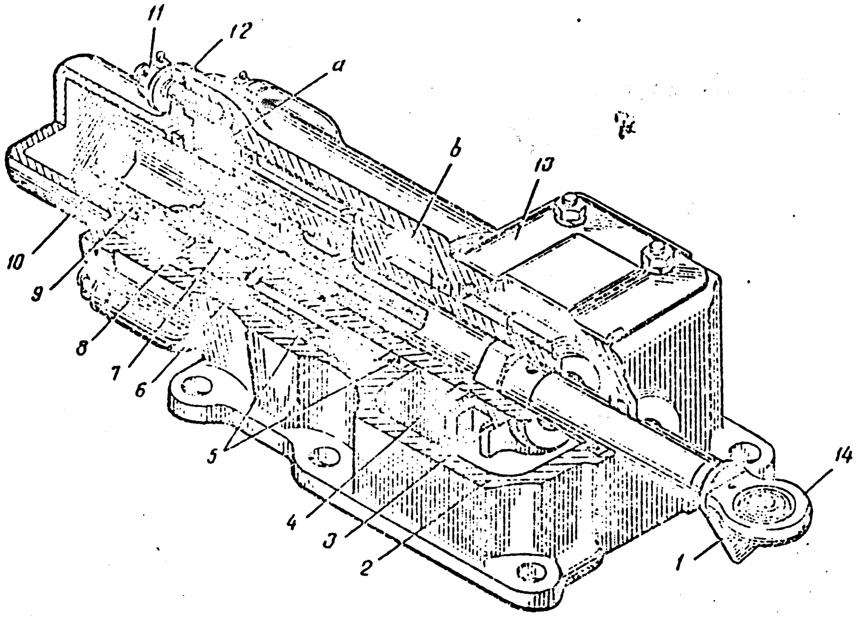

FIG. 202. GEARBOX CONTROL HYDRAULIC SERVOCYLINDER

1 - slide valve position index; 2 - hydraulic servocylinder body; 3 - piston coupling; 4 - hydraulic servocylinder piston; 5 - packing cups; 6 - slide valve; 7 - slide valve back-moving spring; 8 - spring bushing; 9 - bushing stop; 10 - cover of hydraulic servocylinder; 11 - nut; 12 - gasket, 13 - cover of hydraulic servocylinder; 14 - ball joint; a, b - spaces

Motion is transmitted from one group of balls to the other through lockpin 32 secured in the through drilled hole of the middle shaft.

Retainers 30 fix the shafts in engaged and neutral positions. The retainers consist of balls and springs 31. The balls are held by springs in one of the three annular slots of the shifter shafts, thus preventing the latter from spontaneous displacement.

7.3.3. Operation of Gearbox and Its Control System

Neutral position. Lever 13 is kept in a neutral position by spring 35. Gear choice lever 33 is in the slot of coupling 37 of the 4th and 5th gear shifter shafts. The ball retainers are in the middle recesses of the shifter shafts, thus locking the latter.

The gear shifting coupling is not meshed with the gears, and no rotation is transmitted from the driven shaft of the gearbox to the load shaft.

To engage the 1st and reverse speed gear, release the engine clutch, pull gear shift lever 13 and turn it upward (to provide the 1st speed). As a result, shaft 20 displaces, and gear choice lever 33 enters the slot of coupling 37 of 1st and reverse speed gear shifter shaft 27. As the lever is shifted, the coupling turns the shaft with the fork through shaft 27, control rod 4 and lever 6, and thus engages coupling 7 (Fig.199) with the respective gear.

[redacted]

Rotation is transmitted from bevel gear 17 to driven shaft 14 and from gear 18 to gear 8, to toothed coupling 7 and load shaft (1st speed). With the reverse speed engaged, rotation is transmitted from gear 18 to intermediate reverse gear 5 (Fig.200), permanently meshed with it, then to gear 6 (Fig.199), toothed coupling 7 and load shaft 10.

As rotation is imparted through the intermediate gear, the load shaft rotates in a reverse direction.

To engage the 2nd or 3rd speed gear, push lever 13 (Fig.201) upward (2nd speed) or downward (3rd speed). In this case, gear choice lever 33 enters the slot of coupling 37 of shifter shaft and displaces the latter. Shifter shaft 28 through control rod 3 shifts slide valve 6 (Fig.202) of the servocylinder. The slide valve admits oil from the slide valve box into space "a" and connects space "b" with the drain line. The oil pressure displaces piston 4, and the latter turns the gear shift fork by the slot of coupling 3. The fork shifts the synchronizer ring and engages the gear. Rotation is transmitted from the drive shaft to the driven shaft, to 2nd speed gear 20 (Fig.199), gear 5 and through the toothed coupling to load shaft 10.

To engage the 4th and 5th speed gears, move the gear shift lever from the neutral position downward (4th speed) or upward (5th speed).

For further operation, see engagement of the 2nd and 3rd speed gears.

7.3.4. Care of Gearbox

Care of the gearbox includes:

- checking of the oil level in the gear case;
- replenishing of the latter with oil;
- renewal of oil;
- checking of tightening of the bolts securing the power plant (the engine and gearbox);
- washing of the hydraulic vortex tube of the gearbox;
- checking of the control system for adjustment.

To check the oil level in the gearbox, unscrew the plug of dipstick 6 (Fig.200), remove and wipe the latter. Put the dipstick on its place so that the flat of the dipstick head mates with the cover projection. Remove the dipstick and check the oil level. The oil level must be at the upper mark.

For replenishing the gear case, do the following:

(a) insert a funnel with an extension piece and filter in the dipstick hole and add oil up to the upper mark;

(b) reinstall the dipstick and plug.

Renewing the oil in gearbox.

Renew the oil in the gearbox every 4800-5000 km of run as follows:

(a) clean vehicle bottom armour plug 10 (Fig.13) from dust and dirt and unscrew it;

(b) clean the gearbox drain valve plug from dust and dirt, unlock it and unscrew;

(c) prepare a clean container;

(d) screw a wrench for draining oil into the gear case hole (connect a hose to the wrench beforehand);

(e) drain the oil into the container;

(f) unscrew the wrench for draining oil, disconnect the hose and put in place;

(g) screw in the plug of the gearbox drain valve and lock it;

(h) screw in the armour plug;

(i) remove dust and dirt from armour plug 3(Fig.14) of the gearbox dipstick access hole, unlock it and unscrew, take out the dipstick;

(j) insert the funnel with the extension piece and filter in the dipstick hole and fill the gear case with oil up to the upper mark;

(k) fit the dipstick in its place;

(l) screw in the armour plug.

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[redacted]

ed on the ends of the slide valves coincide with the marks on top of the gear case. Otherwis proceed with adjustment by means of rod ends 10 (Fig.201). For this purpose, disconnect the control rod from the slide valve, loosen locknut 40 and, align the index with the mark by screwing or unscrewing end 10.

7.4. PLANETARY STEERING GEARS AND STOPPING BRAKES

7.4.1. Purpose and Design

The planetary steering gears serve to steer the vehicle, to increase the traction force on the driving sprockets for a short time, to brake and stop the vehicle.

The planetary steering gears (Fig.203) are of a double-stage type; they steer the vehicle by imparting different speeds to the tracks.

The steering gears are mounted in cylindrical cases 3 attached to both sides of the gea case with the help of studs 1 and nuts 2.

Each steering gear assembly comprises single-row planetary reduction gear, blocking clutch and disc brake.

The planetary reduction gear consists of epicyclic gear 6 fitted on the splines of load shaft 36 of the gearbox, carrier 21 with three planet pinions 31 fitted on needle bearings 32 of axles 33 which are secured in the carrier, and sun gear 22 rigidly connected with outer drum 8 of the blocking clutch.

The external teeth of epicyclic gear 6 are meshed with the internal teeth of driving discs 5 of the blocking clutch.

Planet pinions 31 are permanently meshed with sun gear 22 and epicyclic gear 6.

The blocking clutch with the disc brake is designed to change transmission ratio of the planetary steering gear. It has three positions: engaged, disengaged and intermediate.

The blocking clutch consists of three steel driving discs 5, four steel driven discs 4 bearing a 1-mm thick cerametallic layer and having sloping grooves to direct the oil flow, outer (driven) drum 8, pressure plate 30, thirty eight pressure springs 7, support disc 28, and inner drum 6 serving also as the epicyclic gear of the planetary gear set.

Carrier 21 is made integral with the shaft whose bronze bushings 25 hold sun gear 22 (free fit). Gear wheel 19 mounted on the splined end of the carrier shaft is semi-rigidly connected with the final drive. Bolted to the gear wheel is brake drum 13 of the stopping brake.

The blocking clutch has a hydraulic release mechanism consisting of booster 29 (power cylinder) and piston 30 which serves also as the pressure plate of the blocking clutch booster. Provided on the outer surfaces of the booster are rubber sealing cups.

In the initial position the blocking clutch is kept engaged by springs 7. It is diseng ed by the oil delivered to booster 29.

Disc brake 11 consists of the steel discs engaged through their slots and supporting pins 26 with the gear case, four discs having a cerametallic coat, inner drum made integral with outer drum 8 of the blocking clutch, pressure plate 14, support disc 20, nine release springs 12 and piston 15.

In the initial position the brake is released due to spring 12. The brake is applied by the use of oil delivered to the booster. The booster is formed by the space bored in cover 10 provided with circular piston 15. The outer surface of the piston and the booster groove hold rubber cups 23 and 24.

The disc brake as well as the blocking clutch operate in oil.

The band-type stopping brakes are designed to brake the vehicle, to make sharp turns and hold the vehicle on downhills. The right-hand and left-hand brakes are identical.

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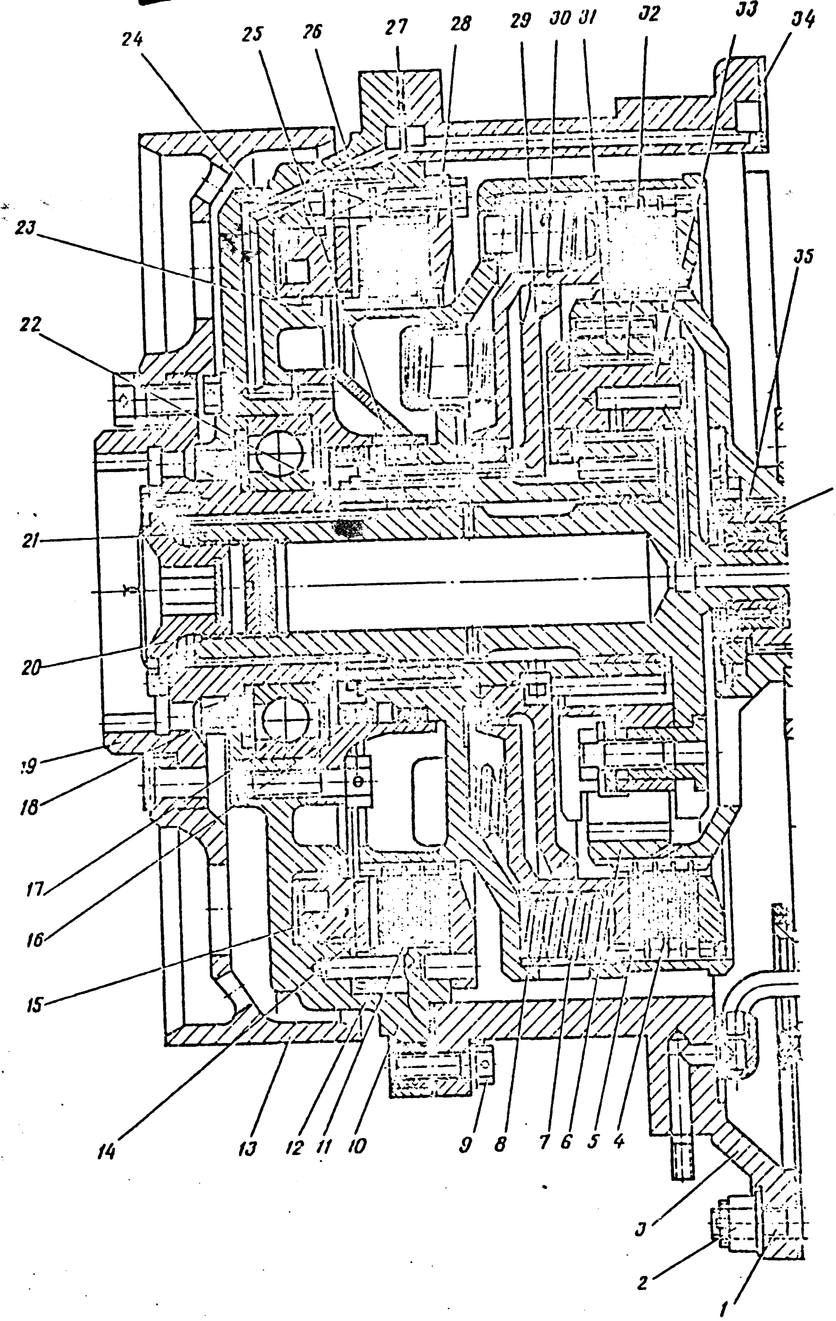

FIG. 203. PLANETARY STEERING GEAR

1 - gear case attaching stud; 2 - nut; 3 - steering gear case; 4 - blocking clutch driven disc; 5 - driving disc; 6 - epicyclic gear of planetary gear set (inner drum); 7 - blocking clutch spring; 8 - outer drum; 9 - steering gear cover attaching bolts; 10 - cover of planetary steering gear case (disc brake booster); 11 - disc brake; 12 - brake release spring; 13 - brake drum; 14 - brake pressure plate; 15 - booster piston; 16 - packing rings; 17 - ball bearing; 13 - cup; 19 - gear wheel of semi-rigid connection coupling; 20 - carrier plug, 21 - carrier of planetary gear set (driven shaft); 22 - planetary gear set sun gear; 23 - piston inner packing cup; 24 - outer packing cup, 25 - bronze bushing (bearing); 26 - supporting pin; 27 - gasket, 28 - support disc; 29 - blocking clutch booster; 30 - piston (pressure plate of blocking clutch booster); 31 - planet pinion; 32 - needle bearing; 33 - planet pinion axle; 34 - gasket; 35 - carrier needle bearing; 36 - gearbox load shaft

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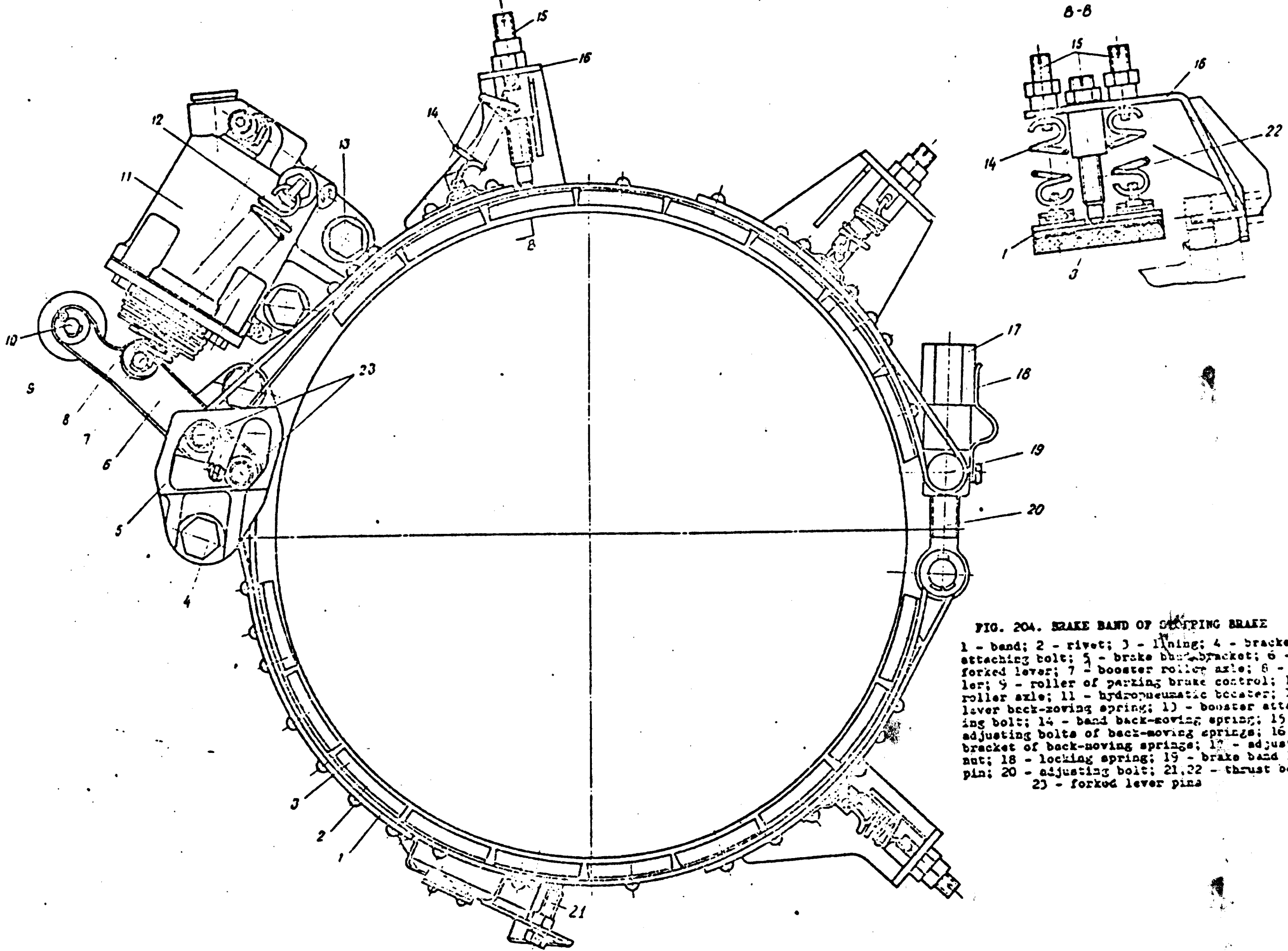

FIG. 204. BRAKE BAND OF STOPPING BRAKE

1 - band; 2 - rivet; 3 - lining; 4 - bracket attaching bolt; 5 - brake band bracket; 6 - forked lever; 7 - booster roller axle; 8 - roller; 9 - roller of parking brake control; 10 - roller axle; 11 - hydropneumatic booster; 12 - lever back-moving spring; 13 - booster attaching bolt; 14 - band back-moving spring; 15 - adjusting bolts of back-moving springs; 16 - bracket of back-moving springs; 17 - adjusting nut; 18 - locking spring; 19 - brake band loop pin; 20 - adjusting bolt; 21,22 - thrust bolts; 23 - forked lever pins

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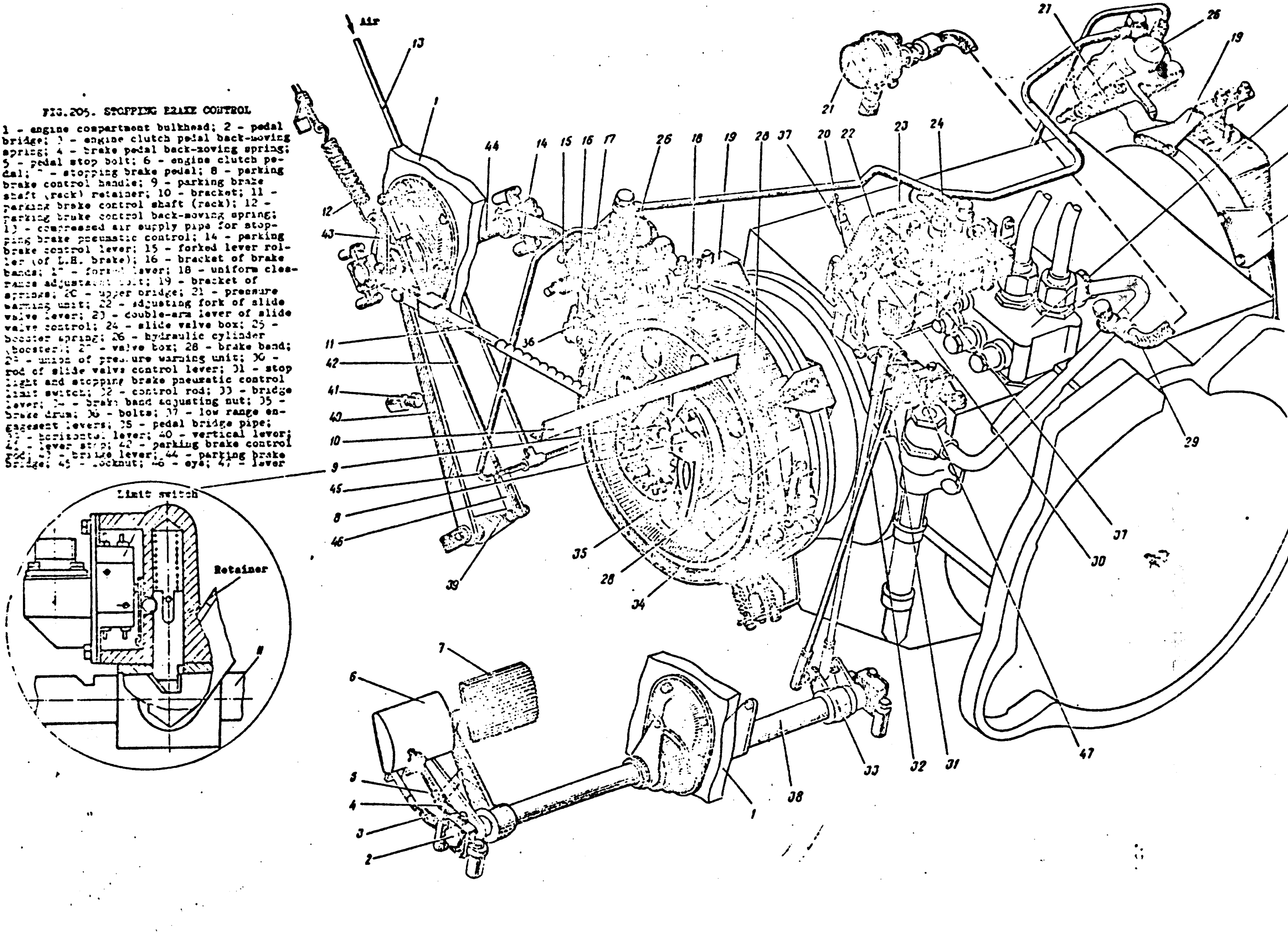
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1
7
6
5
4
3
2
Limit switch
Retainer
8

FIG.205. STOPPING BRAKE CONTROL

1 - engine compartment bulkhead; 2 - pedal bridge; 3 - engine clutch pedal back-moving spring; 4 - brake pedal back-moving spring; 5 - pedal stop bolt; 6 - engine clutch pedal; 7 - stopping brake pedal; 8 - parking brake control handle; 9 - parking brake shaft (rack) retainer; 10 - bracket; 11 - parking brake control shaft (rack); 12 - parking brake control back-moving spring; 13 - compressed air supply pipe for stopping brake pneumatic control; 14 - parking brake control lever; 15 - forked lever roller (of L.H. brake); 16 - bracket of brake bands; 17 - forked lever; 18 - uniform clearance adjustment bolt; 19 - bracket of springs; 20 - upper bridge; 21 - pressure warning unit; 22 - adjusting fork of slide valve lever; 23 - double-arm lever of slide valve control; 24 - slide valve box; 25 - booster spring; 26 - hydraulic cylinder (booster); 27 - valve box; 28 - brake band; 29 - union of pressure warning unit; 30 - rod of slide valve control lever; 31 - stop light and stopping brake pneumatic control limit switch; 32 - control rod; 33 - bridge lever; 34 - brake band adjusting nut; 35 - brake drum; 36 - bolts; 37 - low range engagement levers; 38 - pedal bridge pipe; 39 - horizontal lever; 40 - vertical lever; 41 - lever stop; 42 - parking brake control rod; 43 - brake lever; 44 - parking brake bridge; 45 - locknut; 46 - eye; 47 - lever

of driven shaft 21 of the planetary steering gear, brake band covered from the inside with riveted reinforced retinax linings 3 (Fig.204), four back-moving springs 14, adjusting device, forked lever 6 with two rollers (on the left-hand brake) and one roller (on the right-hand brake) and back-moving spring 12.

The brake band consists of two halves whose ends are bent to form loops. At one end of the loop the bands are connected through pins 19 with the adjusting device, and at the other end, they are connected through pins 23 with forked lever 6.

The adjusting device includes bolt 20 with adjusting nut 17 and locking plate spring 18. The forked lever has two slots to receive pins 23 whose ends enter the shaped slots of bracket 5. The latter is secured with bolts 4 to the gear case. The middle portion of the pins bears the loops of the brake band halves. Two rollers 8 and 9 of the left-hand stopping brake are fitted on axles 7 and 10 in the fork of lever 6. Roller 9 serves to actuate the parking brake, and roller 8 serves to transmit the pressure of the end of the piston of booster 11. As lever 6 is turned, pins 23 moving over the shaped slots, bring the band ends together, and tighten the brake drum. Uniformity of the clearance between the band and drum is achieved by means of adjusting bolts.

The stopping brake control is of a hydraulic servo type.

It consists of pedal 7 (Fig.205), control rod 32, upper bridge 20, levers 23 with control rod 30, slide valve, two hydraulic cylinders 26 and pipelines. The hydraulic cylinders are attached with bolts 36 to the gear case. Hydraulic cylinder (booster) 26 consists of body 3 (Fig.206), piston 4 with end 13, rod 5 and pipe unions 6 and 7. The piston is joined with the end by means of pin 12.

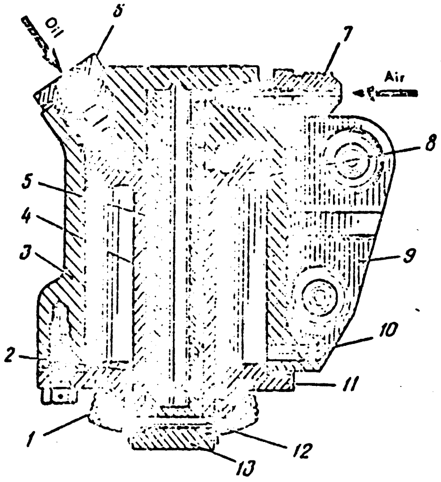

FIG.206. HYDRAULIC CYLINDER (BOOSTER)

1 - protective boot; 2 - rod packing ring; 3 - booster body; 4 - booster piston; 5 - rod; 6 - oil supply union; 7 - compressed air supply union; 8 - booster piston packing; 9 - bracket for fastening of booster to gear case; 10 - drain hole; 11 - body cover; 12 - connecting pin; 13 - rod end

7.4.2. Planetary Steering Gear Control

The planetary steering gear control consists of two components:

(a) low range control,

(b) vehicle steering control.

The low range control provides straight-forward movement of the vehicle at a low speed (without shifting in gears) by changing the transmission ratio in both planetary steering gears from 1 to 1.44.

The transmission ratio of the planetary steering gears is increased by releasing the blocking clutches and applying the disc brakes.

The control consists of lever 19 (Fig.207) located on the steering column, shaft 26 with levers 27 welded to it, control rods 3 and 12 hinge-joined with levers 4 and 10 which control steering slide valves.

The vehicle steering control consists of steering handle bar 18 mounted on the steering column, shaft 25 rigidly connected with the handle bar, levers 23 and 24 secured on the shaft, control rods 2 and 11 and levers 4 and 10 controlling the steering slide valves.

The shaft mounts movable stop 20, and the steering column bears a welded strap with handle bar turn limiter bolts 21 and 22. The stop and limiter bolts make it possible to

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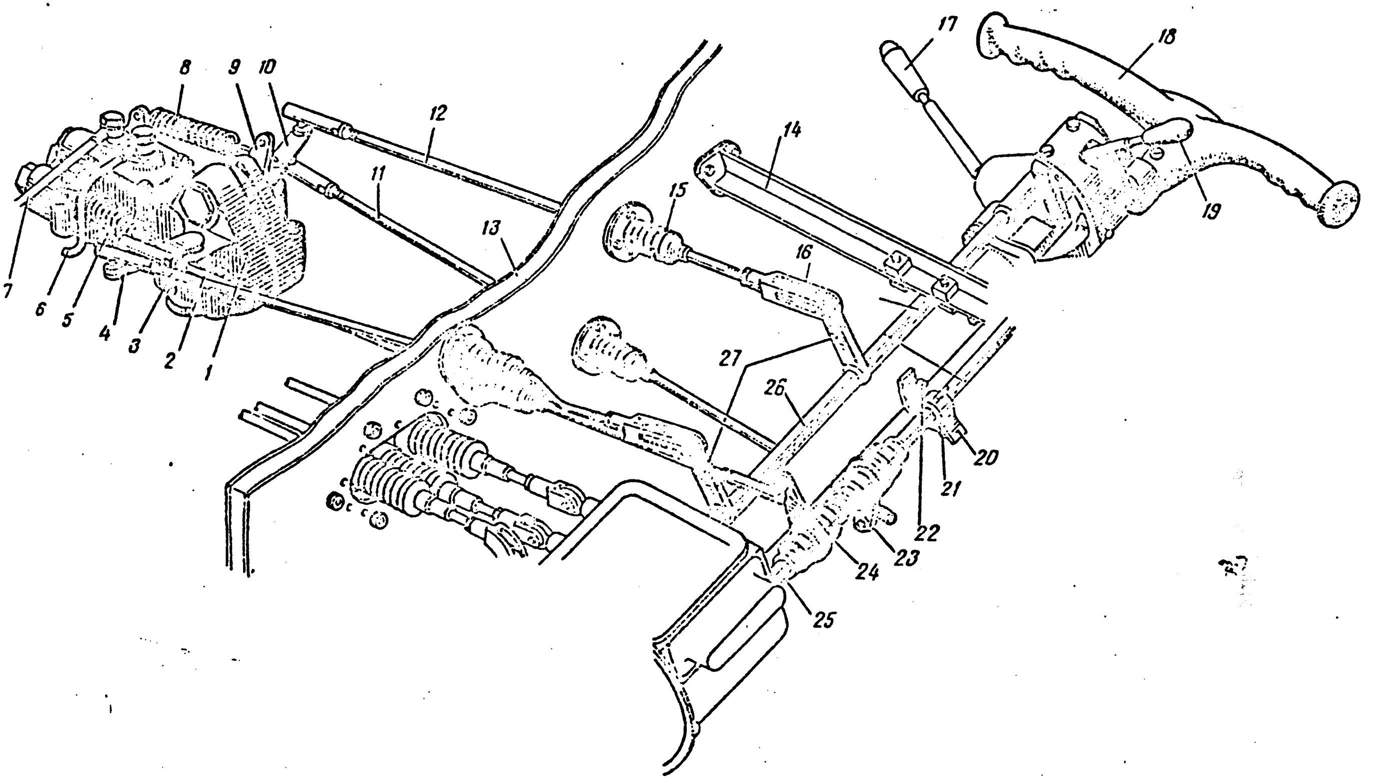

FIG. 207. STEERING GEAR CONTROL

1 - slide valve box; 2 - L.H. steering gear control rod; 3, 12 - low range engagement rods; 4 - upper lever of L.H. steering gear turn slide valve; 5 - lever return spring; 6 - oil supply pipeline to R.H. stopping brake booster; 7 - oil supply pipeline to L.H. stopping brake booster; 8 - return spring; 9 - stopping brake slide valve control lever; 10 - upper lever of R.H. steering gear turn slide valve; 11 - R.H. steering gear control rod; 13 - engine compartment bulkhead; 14 - control column fastening bracket; 15 - protective boot; 16 - fork of low range engagement rod; 17 - gear shift lever; 18 - steering handle bar; 19 - low range engagement lever; 20 - steering shaft movable stop; 21 - handle bar left turn limiter bolt; 22 - handle bar right turn limiter bolt; 23 - R.H. steering gear control lever; 24 - L.H. steering gear control lever; 25 - steering shaft; 26 - low range lever shaft; 27 - levers

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the slide valve box at maximum handle bar turn angles.

Shaft 25 holds two pressed-in lockpins which enter the slots of the hubs of levers 23 and 24. As the handle bar is turned, first lockpin thrusts against the edge of the hub slot, and turns the lever, while the second lockpin freely moves over the slot of the second lever, without shifting it. The second lever is held in the initial position by a spring.

When the handle bar is turned to the other side, the second lockpin thrusts, and the first lockpin freely slides. Such a construction provides independent steering slide valve control.

The steering slide valves are arranged in slide valve box 1 which is closed from above with cover 13 (Fig.208).

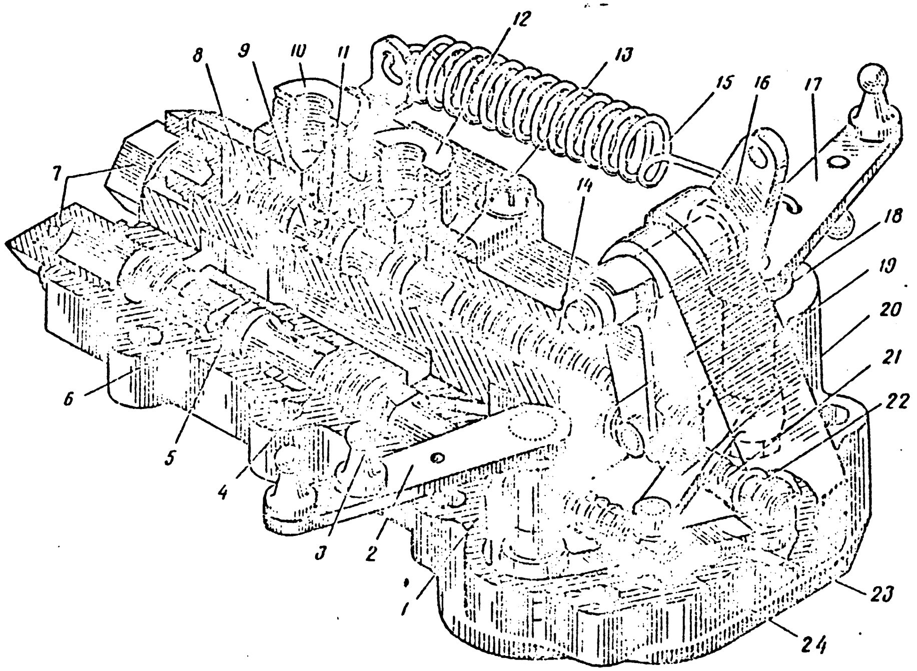

FIG.208. SLIDE VALVE BOX

1 - slide valve box; 2 - upper lever of L.H. steering gear turn slide valve; 3 - slide valve bevel; 4 - R.H. steering gear turn slide valve; 5 - slide valve flat; 6 - duct for passage of oil from space behind plunger; 7 - plugs; 8 - stopping brakes control slide valve; 9 - duct in slide valve; 10 - union for oil supply to L.H. stopping brake booster; 11 - flat, 12 - union for oil supply to R.H. stopping brake booster; 13 - cover of slide valve box; 14 - slide valve spring; 15 - upper lever back-moving spring; 16 - stopping brakes slide valve control lever; 17 - upper lever of R.H. steering gear turn slide valve; 18 - L.H. steering gear turn slide valve; 19 - spring thrust bushing; 20 - lower lever of R.H. steering gear turn slide valve; 21, 24 - slide valve springs; 22 - grooves for block of slide valve control lower lever; 23 - lower lever of L.H. steering gear turn slide valve

The slide valve box is bolted from the outside of the gear case. The box has two longitudinal channels to accommodate slide valves. The channels are stopped with plugs 7. Slide valves 4, 8, and 18 are, in fact, steel stems having grooves, chamfers, flats 5 and bosses which admit the oil to any of the channels and stop the oil supply. The ends of the slide valves are fitted with spring stop bushings 19 which have milled grooves 22 to receive the retaining blocks of

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the slide valve control levers. The box has slide valve 4 to control the
steering gear, slide valve 18 to control the left-hand planetary steering gear, and slide valve 8 to control stopping brakes. The steering slide valves are controlled by double-arm levers 2 and 17; each of the levers is connected with two control rods: low range control rod and steering control rod.

The slide valves are fitted with springs 14, 21 and 24 which hold the slide valves against spontaneous displacement.

The body has a number of ducts connecting the booster oil lines with the oil pump and drain line.

7.4.3. Operation of Planetary Steering Gears and Planetary Steering Gear Control

The initial position of handle bar 18 (Fig.207) is a middle (horizontal) one with low range engagement lever 19 in an upper position, levers 4 and 10 of the right-hand and left-hand steering slide valves kept in the rearmost position by springs 5 and 8, and the slide valves held by springs 21 (Fig.208) and 24 in the initial position at which no oil is delivered from the pump, and the spaces communicating with the hydraulic control system are connected with the drain line.

The low range is engaged by shifting lever 19 (Fig.207) downward. Shaft 26 with levers 27 turns simultaneously with lever 19, and shifts control rods 3 and 12 which in their turn displace slide valves 5 and 12 (Fig.209) through levers 4 and 15. As the slide valves move, they admit oil to the boosters of blocking clutches 9 and disc brakes 8. Actuated by the oil pressure, pressure plate (piston) 18 of the blocking clutch moves away compressing springs 20, as a result, the friction discs are brought apart.

The oil in the brake booster displaces piston 21; the latter, overcoming the effort of springs 19, brings the discs together, and brakes sun gear 22.

Rotation is transmitted from load shaft 36 (Fig.205) of the gearbox to epicyclic gears 6 of both planetary steering gears and then to planet pinions 31.

As sun gears 22 are braked, the planet pinions run over them, thus pulling axles 33 together with carrier 21 and actuating the drive shafts of the final drives through gear wheels 19 and semi-rigid couplings; the rotational speed of the drive shafts is 1.44 lower than that of the epicyclic gear, and as a result, the speed of the vehicle movement is 1.44 times slower.

As lever 19 (Fig.207) is set to low range, levers 4 and 10 are shifted by control rods 3 and 12; as steering control rods 2 and 11 are also connected to these levers, they will also be shifted due to slots provided in their ends. Therefore, with the low range engaged, the handle bar has a considerable play.

The vehicle is steered by turning the handle bar. The radius of turn depends on the angle of the handle bar turn: the larger the angle of handle bar turn, the smaller the radius of the vehicle turn.

When handle bar 18 is turned to the left through a small angle, shaft 25 is caused to turn together with lever 24 fitted on it. Lever 24 through control rod 2 turns lever 16 (Fig.210), and as a result lever 16 displaces slide valve 11 of the left-hand planetary steering gear. The slide valve opens duct "a" and admits oil to the booster of the blocking clutch of the left-hand planetary steering gear.

The oil pressure in the booster gradually rises, since the oil passes through small bevel 12 of slide valve 11. The oil pressure causes pressure plate (piston) 24 to move and compress pressure springs 18. In this case the discs of blocking clutch 17 gradually starts slipping, thus reducing the speed of the left-hand track and allowing a smooth large-radius turn of the vehicle.

When the blocking clutch is completely released, no torque is transmitted to the left-hand driving sprocket, and the radius of the vehicle turn to the left depends on the ground resistance only.

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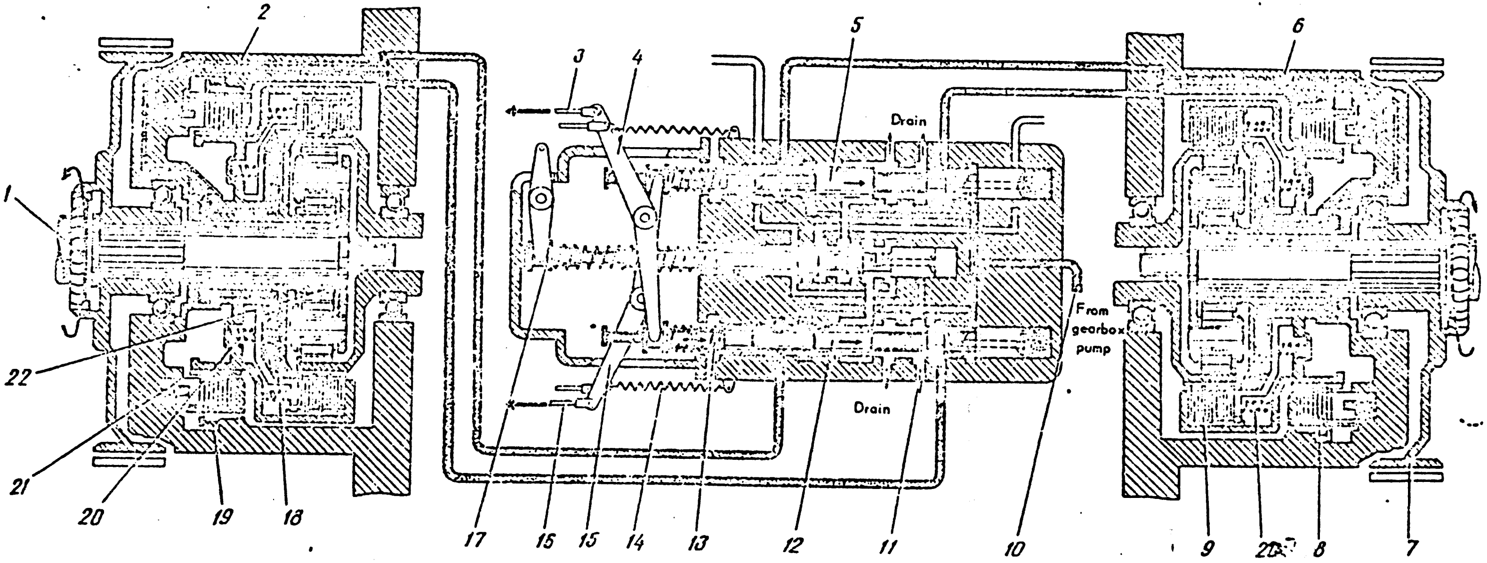

FIG.209. DIAGRAM OF HYDRAULIC CONTROL SYSTEM OPERATION DURING LOW RANGE ENGAGEMENT

1 - gearbox load shaft; 2 - L.H. planetary steering gear; 3 - L.H. planetary steering gear control rod; 4 - upper lever; 5, 12 - R.H. planetary steering gear turn slide valves; 6 - R.H. planetary steering gear; 7 - stopping brake; 8 - planetary steering gear disc brake; 9 - blocking clutch; 10 - union for supply of oil from gearbox pump; 11 - L.H. planetary steering gear turn slide valve; 13 - slide valve spring; 14 - lever spring; 15 - upper lever for control of R.H. planetary steering gear slide valve; 16 - rod; 17 - stopping brakes control slide valve; 18 - blocking clutch pressure plate (piston); 19 - disc brake springs; 20 - blocking clutch spring; 21 - disc brake booster piston; 22 - sun gear of planetary gear set

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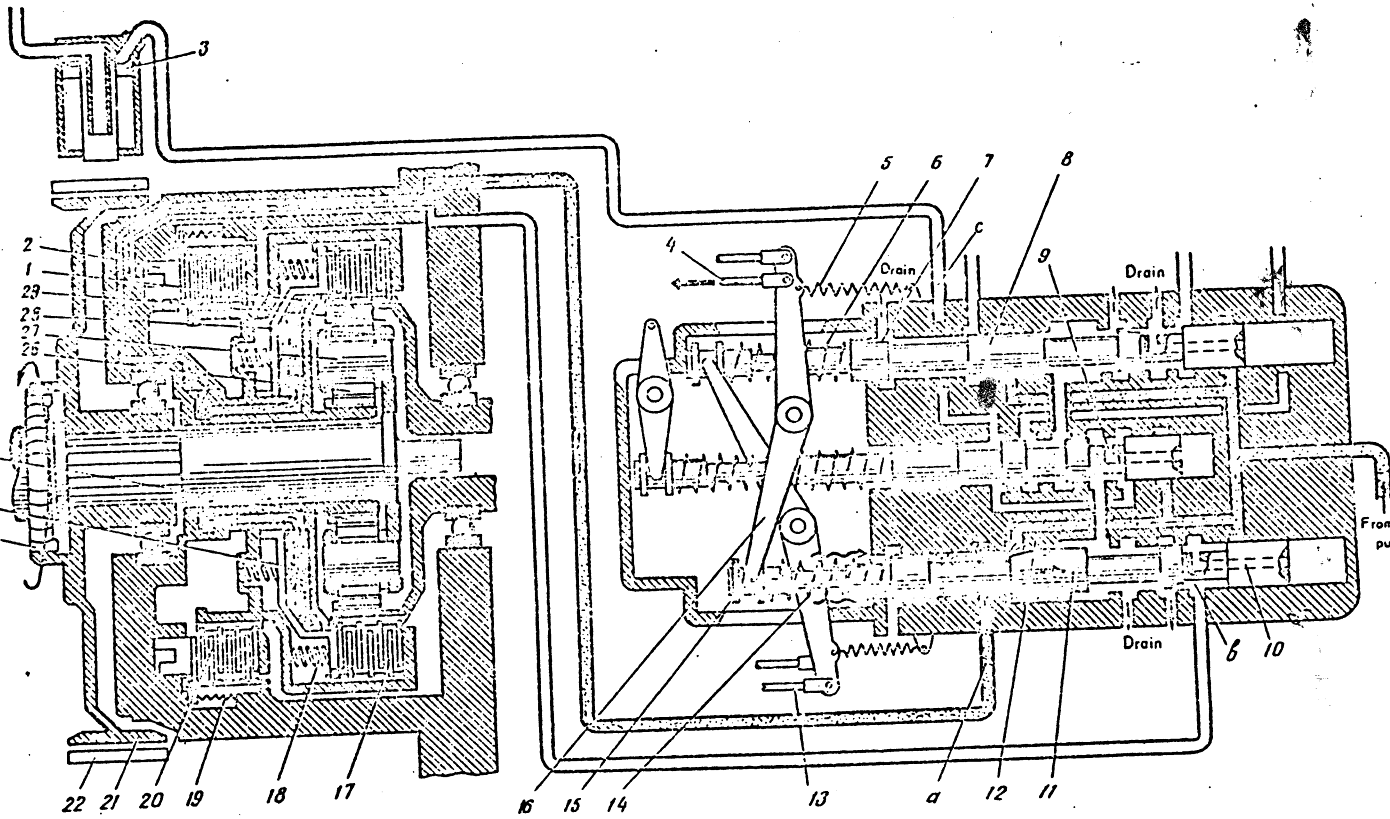

FIG.210. DIAGRAM OF HYDRAULIC CONTROL SYSTEM OPERATION IN CASE OF HANDLE BAR TURN TO THE LEFT THROUGH A SMALL ANGLE (FREE TURN)

1 -blocking clutch booster; 2 - piston of planetary steering gear disc brake booster; 3 - stopping brake booster piston; 4 - control rod of L.H. planetary steering gear slide valve; 5 - lever spring; 6 - slide valve spring; 7 - slide valve bevel; 8 - R.H. planetary steering gear control slide valve; 9 - stopping brakes control slide valve; 10 - duct for passage of oil from space behind plunger; 11 - L.H. planetary steering gear control slide valve; 12 - slide valve bevel; 13 - low range rod; 14 - slide valve spring; 15 - spring thrust bushing with recess for slide valve control lever block; 16 - upper lever for control of L.H. slide valve; 17 - blocking clutch; 18 - blocking clutch pressure spring; 19 - disc brake pressure spring; 20 - disc brake; 21 - stopping brake drum; 22 - stopping brake band; 23 - semi-rigid connection coupling; 24 - pressure plate (piston); 25 - sun gear; 26 - planet pinion; 27 - planet pinion axle; 28 - carrier; 29 - epicyclic gear; a - duct for supply of oil to booster of L.H. planetary steering gear blocking clutch; b - duct for supply of oil to disc brake booster; c - duct for supply of oil to stopping brake booster

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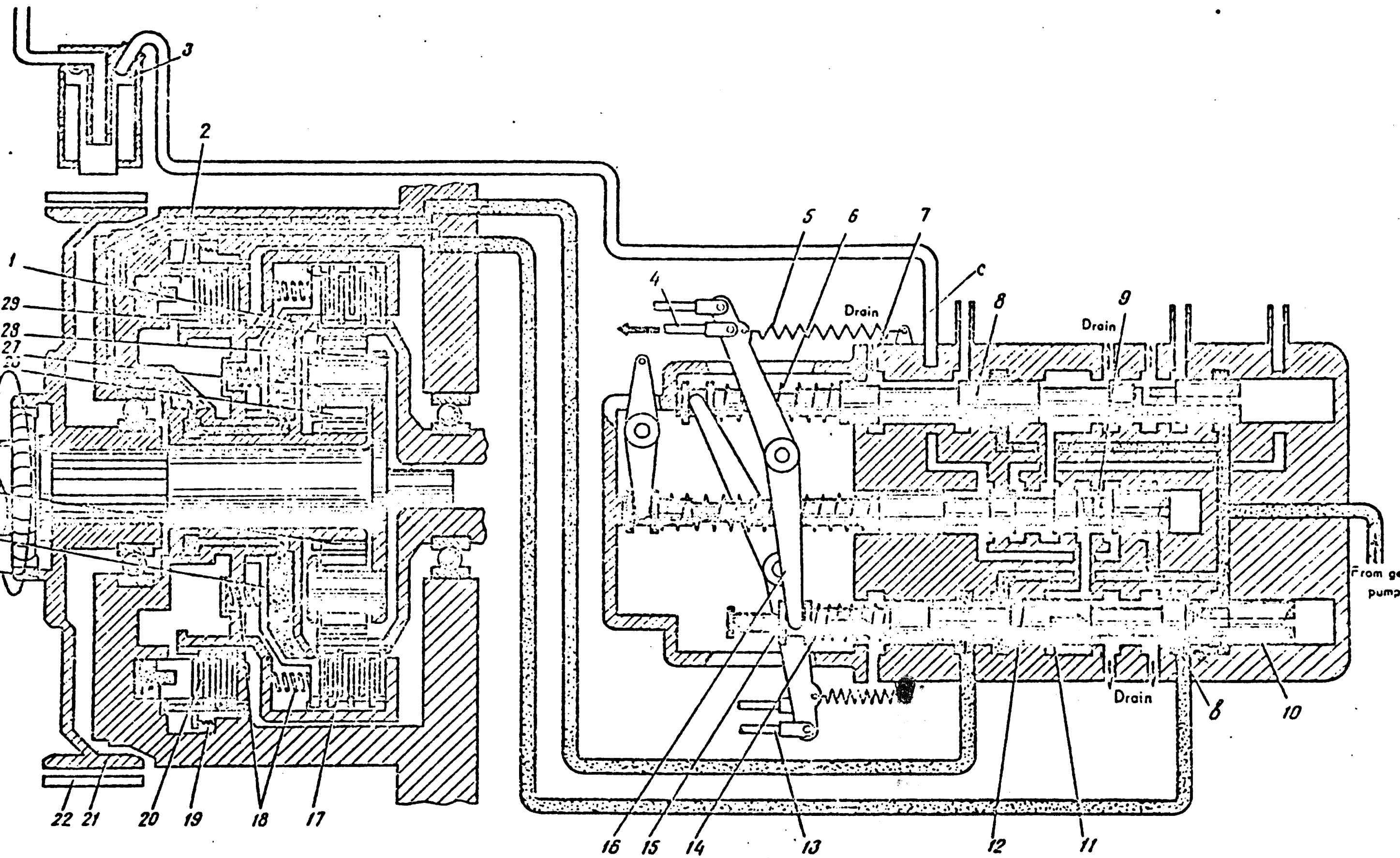
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21
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12
11

FIG.211. DIAGRAM OF HYDRAULIC CONTROL SYSTEM OPERATION IN CASE OF HANDLE BAR TURN THROUGH A LARGE ANGLE (TURN WITH FIXED RADIUS)

(For designations refer to Fig.210.)

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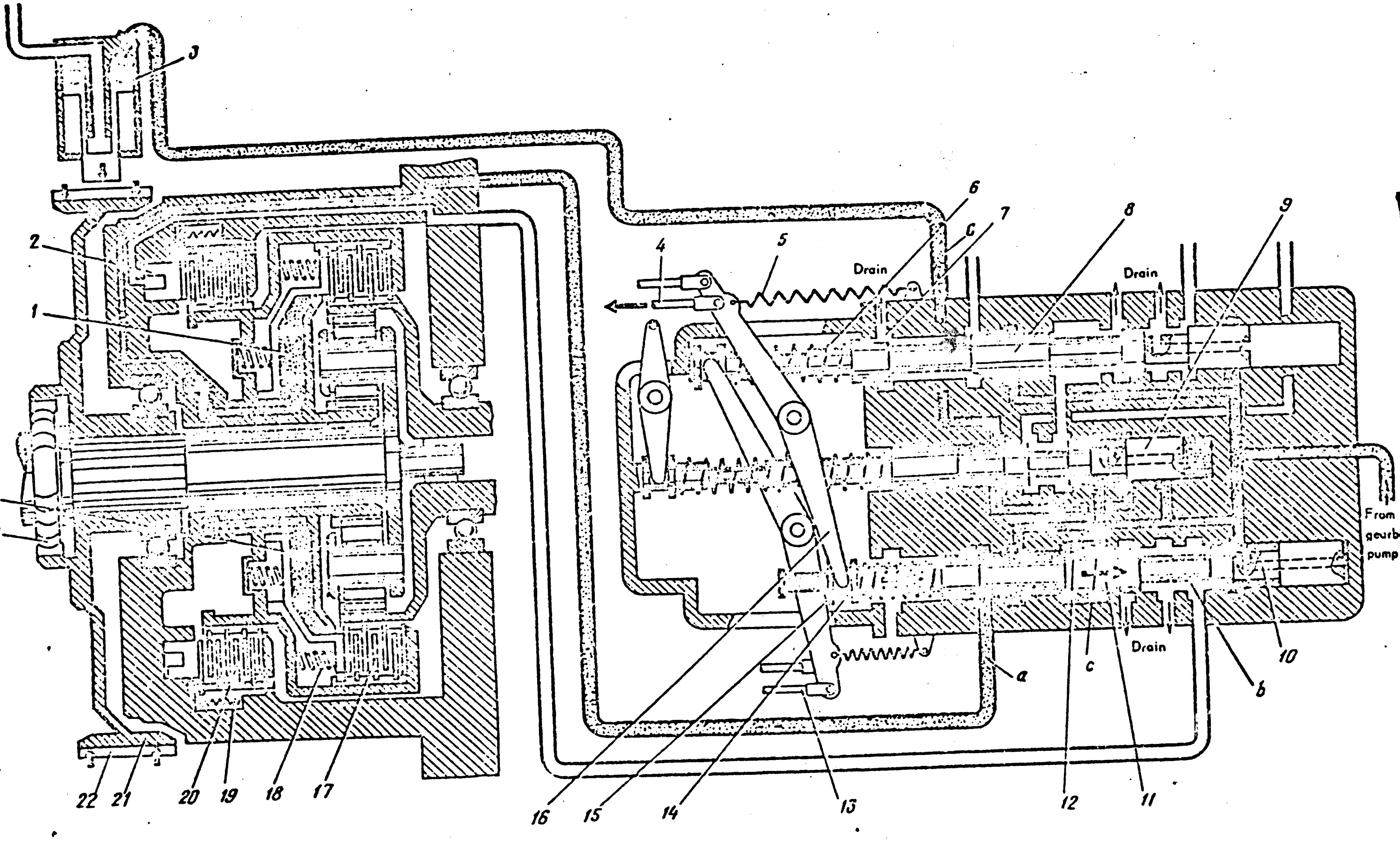
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19
18
17
16
15
14
13
a
12
c
11
Drain
b
10

FIG.212. DIAGRAM OF HYDRAULIC CONTROL SYSTEM OPERATION IN CASE OF MAXIMUM TURN OF HANDLE BAR (TURN WITH MINIMUM RADIUS)

(For designations refer to Fig. 210.)

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valve 11 moves further, oil duct "a" leading to the blocking clutch booster remains open, oil duct "b" leading to the disc brake booster open. Piston 2 (Fig.210) (pressure plate) of the brakes moves and presses the friction discs of disc brake 20, overcoming the effort of springs 19, and slightly braking sun gear 25. As a result, the torque is transmitted from epicyclic gear 29 to planet pinions 26, and partially to carrier 28 since, as the slippage of the friction discs decreases, the planet pinions run over the sun gear more and pull the carrier through their axles 27. The track slows down, and the radius of turn decreases.

When disc brake 20 is fully applied, sun gear 25 stops, and the speed of the retarding track is 1.44 times less than that of the other track. The vehicle makes a fixed-radius turn.

To make a sharp turn about the fixed track, turn the steering handle bar as far as it will go. As a result, steering control slide valve 11 (Fig.212) move additionally and opens the drain duct. The oil drains from the booster of planetary steering gear brake 20 into the gear case, and brake piston 2 (pressure plate) returns to the initial position, thus releasing the friction discs. Then, slide valve 11 opens oil duct "c" which leads to the booster of stopping brake band 22. The oil forced to the space over piston 3, causes the latter to move downward. The piston actuates the roller of lever 17 (Fig.205) and tightens stopping brake band 28. The blocking clutch remains released, the track is stopped by the brake and the vehicle makes a minimum-radius turn.

To brake the vehicle by the stopping brakes, press pedal 7. As a result, pipe 38 turns together

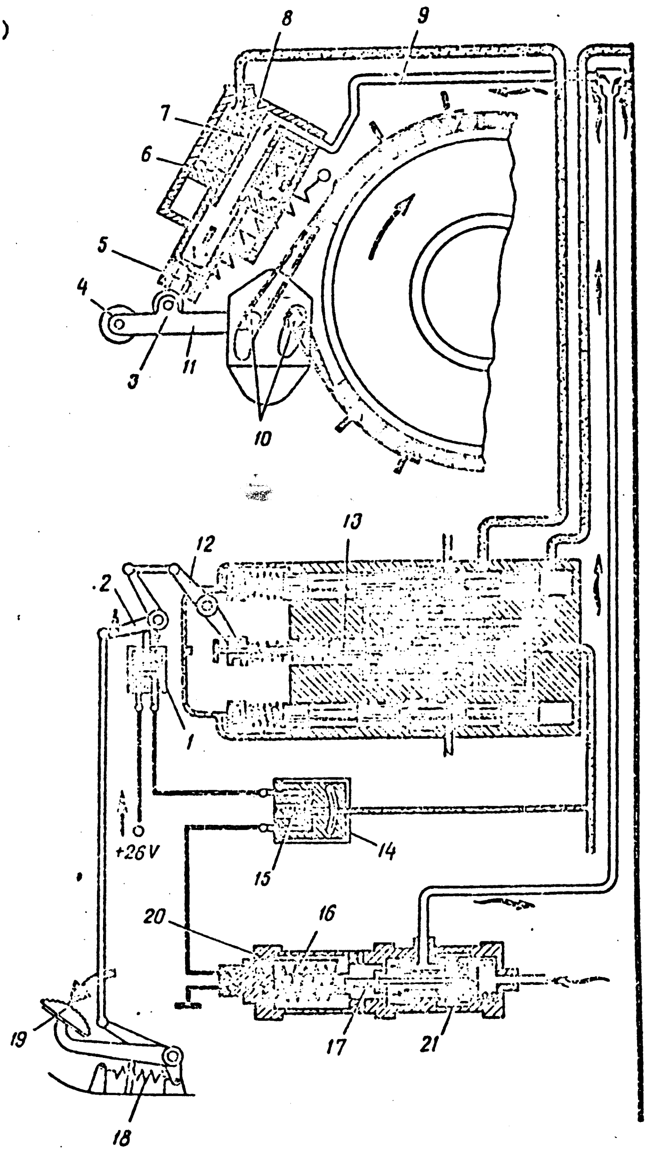

FIG.213. OPERATION DIAGRAM OF STOPPING BRAKE PNEUMATIC CONTROL

1 - limit switch; 2 - stopping brakes control lever on upper bridge; 3 - forked lever roller; 4 - parking brake roller; 5 - piston end-piece; 6 - booster piston; 7 - booster rod; 8 - booster; 9 - compressed air pipeline; 10 - forked lever pins; 11 - forked lever; 12 - limit switch button; 13 - stopping brake hydraulic control slide valve; 14 - pressure warning unit; 15 - spring of pressure warning unit; 16 - winding of electropneumatic valve; 17 - core; 18 - back-moving spring; 19 - stopping brakes pedal; 20 - electropneumatic valve; 21 - slide valve

[redacted]

with lever 33 which actuates control rod 32 and the latter turns the lever mounted on adapter bridge 20 which is provided on the gear case. The lever of the upper bridge actuat control rod 30 and the latter turns lever 23 which displaces slide valve 8 (Fig.208) of th stopping brakes. Slide valve 8 opens the oil duct leading to the boosters of the stopping brakes. The oil forced to the booster spaces displaces piston 4 (Fig.206) whose end 13 pushes roller 8 (Fig.204) of lever 6; the latter turns, and pins 19 pull the lower end of the band upwards, and the upper end—downward, thus braking the drum.

In case of faults in the hydraulic system (low pressure or no pressure at all), provision is made for braking with the use of compressed air (pneumatic control). The pneumatic control consists of limit switch 1 (Fig.213), mounted under lever 2 of the upper (adapter) bridge, pressure warning unit 14 and electropneumatic valve 20; besides, the pneumatic control includes rod 7 in booster 8 and pipelines.

The pneumatic control functions as follows: as brake pedal 19 is pressed, limit switch operates and applies the voltage to the contacts of pressure warning unit 14 and further to winding 16 of electropneumatic valve 20.

The electromagnetic force pulls in core 17 and the latter displaces slide valve 21, th admitting the compressed air from the pneumatic system to pipeline 9 leading to boosters 8.

The air entering the space of rods 7 causes the latter to move and to press pistons 6; the latter draw out of the boosters, and tighten the brake bands in the same way as during oil supply.

For detailed description of the design and operation of the pneumatic control , see Section 15.

7.4.4. Parking Brake Control

For holding the vehicle on a downgrade, provision is made for a manual control linkage through which the band of the left-hand stopping brake can be tightened. This control linka can be also used for applying the brakes during towing. As the band of the left-hand brake is tightened, the right-hand driving sprocket is braked together with the left-hand driving sprocket since they are interconnected through the engaged blocking clutches of the planeta steering gears.

The parking brake control linkage consists of handle 8 (Fig.205), secured on toothed shaft 11, retainer 9, vertical lever 40 rigidly connected with horizontal lever 39, control rod 42 hinge-joined with lever 43, adapter bridge 44, pressure lever 14 and light signallin circuit.

To apply the parking brake, pull handle 8. As a result, shaft 11 raises the retainer with its teeth and turns levers 40 and 39 which rotate lever 43 through control rod 42.

Lever 43 secured on the pipe of bridge 44 turns the pipe, and pressure lever 14 pushes roller 15, and thus rotates forked lever 17 and tightens the brake band of the left-hand brake.

To fix the band in a braked state, turn the handle to the vertical position. In this case the retainer engages the teeth of shaft 11 under the action of the spring, and holds the shaft together with the entire control linkage in position. As the retainer engages the teeth , it forces the ball out of the recess and makes it press the plate of the limit switc The plate pushes the microswitch and light signal panel RELEASE HAND BRAKE lights up.

To release the parking brake, turn handle 8 to the left so as to disengage the retainer from the shaft teeth, and place it in the initial position. Then, turn the handle to the right and downward and leave it in the vertical position. The light signal panel goes out.

[redacted]

7.4.5. Care of Planetary Steering Gears and Brakes

Care of the planetary steering gears and brakes includes:

- checking of the steering handle bar, pedals and control levers for condition;
- checking of the hydraulic pipeline, boosters and unit connections for leakage;
- adjustment of the parking brake control linkage and stopping brake bands;
- supervision over condition, attachment and locking of the control rods and hinge joints;
- lubrication of the control linkage bridges.

Check and adjust the control linkage of the parking brake and stopping brakes every 2400-2500 km of run.

For checking pull out handle 8 (Fig.205) of the parking brake as far as it will go and check the number of teeth of shaft 11 protruding beyond the body of retainer 9.

If fourteen or more teeth protrude beyond the body, adjust the stopping brakes as follows:

- raise the front ribbed plate of the hull;
- push handle 8 of the parking brake forward till vertical lever 40 thrusts against stop 41;
- tighten up adjusting nuts 34 of the brake bands and then give them eight revolutions back;
- slacken locknut 45 and disconnect eye 46 from lever 39, then, rotating the eye, adjust the length of control rod 42 so as to obtain a clearance within 0.3-1 mm between lever 14 and roller 15;
- connect control rod 42 with lever 39 and put the front ribbed plate in its place.

When checking the planetary steering gear and brake control functioning make sure that:

(a) the steering handle bar is securely attached and its play does not exceed 10 mm; free travel of the handle bar end is not over 4 mm; as the steering handle bar is turned, the low range engagement lever remains motionless;

(b) the pneumatic system is air tight;

(c) the clearance between the brake bands and drums is uniform (the clearance variation from 0.5 to 3 mm is allowed);

(d) misalignment and overhanging of the bands on the drums does not exceed 1 mm;

(e) the steering handle bar turn angle is correct (with the handle bar placed in extreme positions the stops of the handle bar shaft should thrust against the limiters of the steering column).

7.5. FINAL DRIVES

7.5.1. Purpose and Design

The final drives are designed to increase the torque on the driving sprockets. Both final drives are similar in design, the only difference being that the left-hand final drive has a speedometer drive.

The final drive is a single-stage planetary reduction gear consisting of housing 4 (Fig.214) having internal teeth 2 which serve as an epicyclic gear, drive shaft 27 made integral with the sun gear, three planet pinions 23, carrier 9 made integral with the driven shaft and cover 22.

The final drive housing is bolted to hull armour 20. Cover 22 is bolted to it from inside. The borings of the housing and cover hold ball bearings which mount carrier 9 with the driven shaft and driving sprocket 3 fitted on the splines of the latter. Pins 17 secured in the carrier 9 mount two roller bearings 18 with planet pinions 23. The planet pinions are permanently meshed with the sun gear of shaft 27 and fixed epicyclic gear 2. Therefore, during

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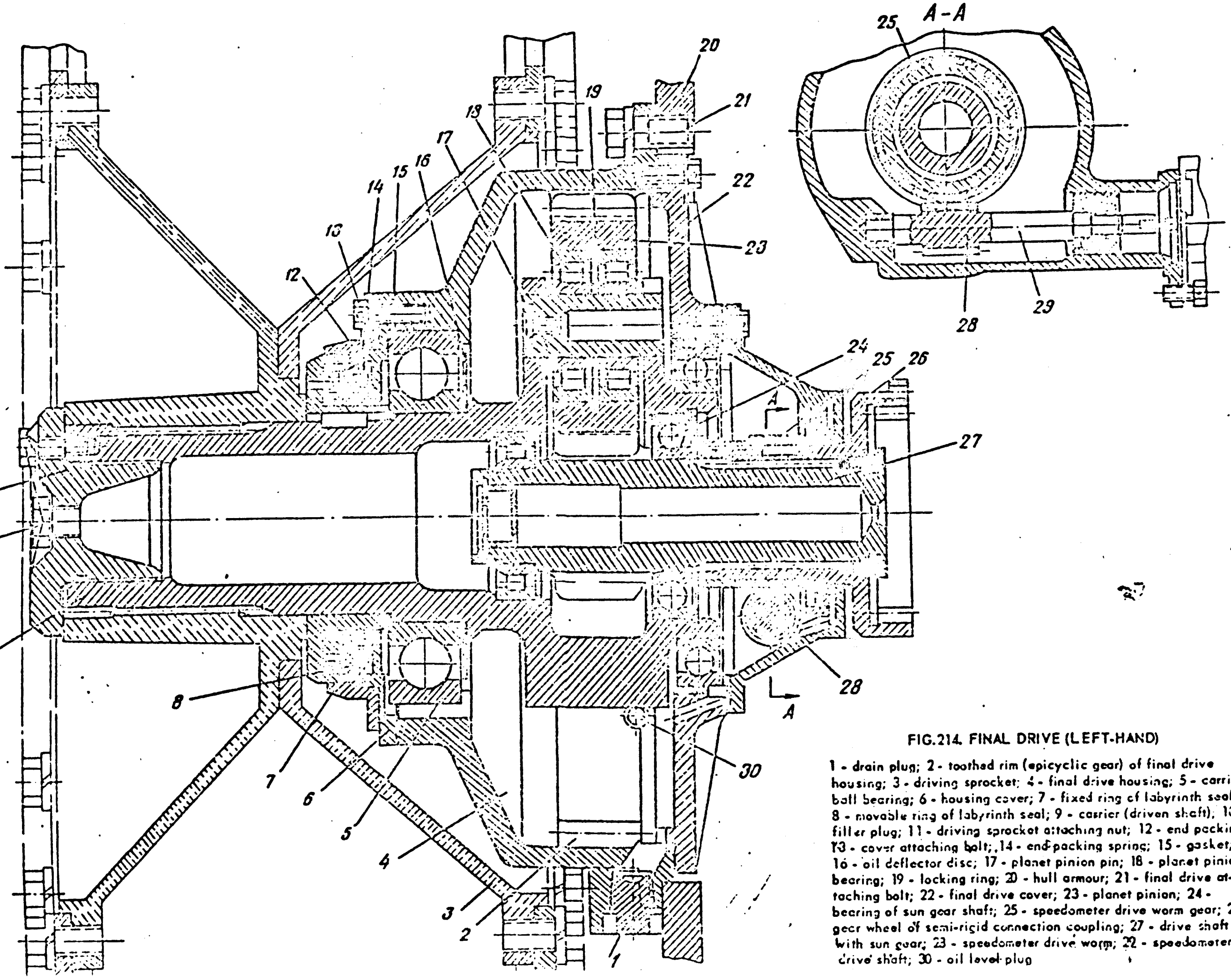

FIG.214. FINAL DRIVE (LEFT-HAND)

1 - drain plug; 2 - toothed rim (epicyclic gear) of final drive housing; 3 - driving sprocket; 4 - final drive housing; 5 - carrier ball bearing; 6 - housing cover; 7 - fixed ring of labyrinth seal; 8 - movable ring of labyrinth seal; 9 - carrier (driven shaft); 10 - filler plug; 11 - driving sprocket attaching nut; 12 - end packing; 13 - cover attaching bolt; 14 - end-packing spring; 15 - gasket; 16 - oil deflector disc; 17 - planet pinion pin; 18 - planet pinion bearing; 19 - locking ring; 20 - hull armour; 21 - final drive attaching bolt; 22 - final drive cover; 23 - planet pinion; 24 - bearing of sun gear shaft; 25 - speedometer drive worm gear; 26 - gear wheel of semi-rigid connection coupling; 27 - drive shaft with sun gear; 23 - speedometer drive worm; 22 - speedometer drive shaft; 30 - oil level plug

[redacted]

rotation of the drive shaft 27 with the sun gear, planet pinions 23 run over the teeth of the fixed epicyclic gear and rotate carrier 9 with the driving sprocket through pins 17.

Worm gear 25 key-fitted on gear wheel 26 of the final drive coupling is meshed with worm 28 made integral with speedometer drive shaft 29.

The end of the shaft has a shank with a slot for connection with the speedometer cable.

Drive shaft 27 is hollow; it revolves in one roller bearing and one ball bearing.

The driving sprocket is held against axial displacement by nut 11; a filler hole provided in the centre of the nut is closed with plug 10.

Oil is drained from the final drive through the drain hole made in the housing and closed with taper plug 1.

There is a level hole closed with plug 30.

The final drives are actuated by the driven shafts of the planetary steering gears through connecting shafts 4 and 8 (*Fig.215*). As the power unit is positioned asymmetrically, the left-hand shaft is longer than the right-hand one. The ends of the connecting shafts are fitted with semi-rigid connection couplings 3.

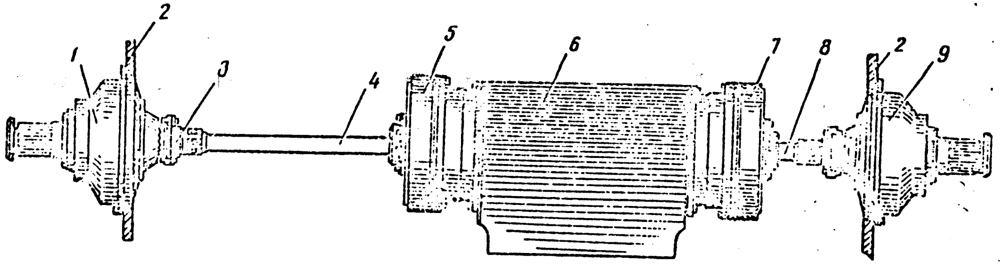

FIG.215. CONNECTING SHAFTS FROM POWER PLANT TO FINAL DRIVES

1 - L.H. final drive; 2 - side armour plate; 3 - semi-rigid connection couplings; 4 - L.H. connecting shaft; 5 - L.H. planetary steering gear; 6 - gearbox; 7 - R.H. planetary steering gear; 8 - R.H. connecting shaft; 9 - R.H. final drive

7.5.2. Care of Final Drives

The care of the final drives includes:

- regular checking of the final drives for heating (by touch) and for lubricant leakage;
- checking of the oil level, replenishing of final drives with oil and renewal of oil.

Check and replenish the final drives with oil every 2400-2500 km of run as follows:

(a) place the vehicle on a level ground;

(b) unlock and unscrew level plug 30 (Fig.214);

(c) as soon as oil starts pouring out of the level hole, screw in and lock the level plug. If oil does not pour out of the hole, replenish the final drive with oil.

Do it as follows:

(a) unscrew the bolts, raise and fix the mudguard over the driving sprocket;

(b) unlock and unscrew filler plug 10; replenish the final drive with oil till the latter appears in the level hole;

(c) screw in the filler and level plugs and lock them.

Renew the oil in the final drives every 4800-5000 km of run as follows:

(a) place the vehicle on a level ground;

(b) unscrew the bolts, raise and fix the mudguard over the driving sprocket;

(c) remove dust and dirt and unscrew level plug 30, filler plug 10 and drain plug 1;

(d) drain the oil into a container;

(e) screw in and lock the drain plug;

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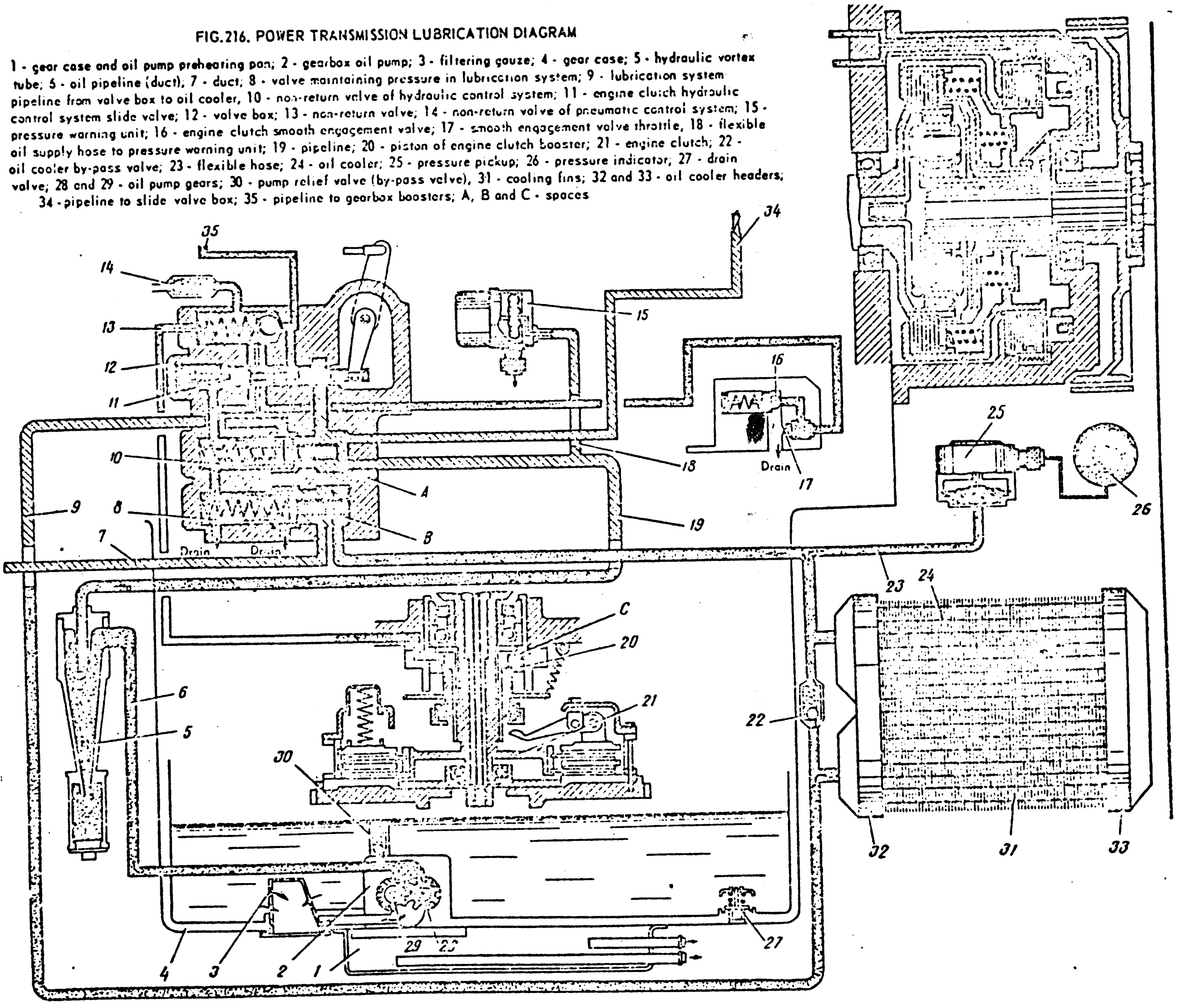

FIG.216. POWER TRANSMISSION LUBRICATION DIAGRAM

1 - gear case and oil pump preheating pan; 2 - gearbox oil pump; 3 - filtering gauze; 4 - gear case; 5 - hydraulic vortex tube; 6 - oil pipeline (duct); 7 - duct; 8 - valve maintaining pressure in lubrication system; 9 - lubrication system pipeline from valve box to oil cooler, 10 - non-return valve of hydraulic control system; 11 - engine clutch hydraulic control system slide valve; 12 - valve box; 13 - non-return valve; 14 - non-return valve of pneumatic control system; 15 - pressure warning unit; 16 - engine clutch smooth engagement valve; 17 - smooth engagement valve throttle, 18 - flexible oil supply hose to pressure warning unit; 19 - pipeline; 20 - piston of engine clutch booster; 21 - engine clutch; 22 - oil cooler by-pass valve; 23 - flexible hose; 24 - oil cooler; 25 - pressure pickup; 26 - pressure indicator; 27 - drain valve; 28 and 29 - oil pump gears; 30 - pump relief valve (by-pass valve), 31 - cooling fins; 32 and 33 - oil cooler headers; 34 - pipeline to slide valve box; 35 - pipeline to gearbox boosters; A, B and C - spaces

[redacted]

(f) using a grease gun, fill the housing through the filler hole till the oil appears in the level hole;

(g) screw in and lock the plugs.

7.6. POWER TRANSMISSION LUBRICATION AND HYDRAULIC CONTROL SYSTEM

7.6.1. Purpose and Design

The lubrication system (Fig.216) is common for the gearbox and planetary steering gear. It is combined with the hydraulic control system of the power transmission.

The system includes oil pump 2, hydraulic vortex tube 5 (oil filter), valve box 12, engine clutch smooth engagement valve 16; oil cooler 24, gear shift hydraulic servocylinders, boosters of the planetary steering gears and engine clutch , pipelines, by-pass valve 22, pump relief valve 30, and fittings.

Oil pump 2 feeds oil to the lubrication system and to the hydraulic control system of the power transmission. It is mounted in the gear case and driven by the engine through a pair of bevel gears and shaft.

The gear oil pump consists of a housing and two spur gears 28 and 29, gauze filter, relief valve 30 and pipelines.

Oil enters the oil pump through filtering gauze 3 directly from the gear case and then passes over duct 6 to hydraulic vortex tube 5.

The hydraulic vortex tube (Fig.217) is a filter designed to clean the oil of mechanical impurities. It is located on the upper half of the gear case (on the left side of the latter). The hydraulic vortex tube consists of cast hollow body 3 having cylindrical and taper portions and bunker 7. Thread provided on top of the body receives pipe union 5 for connection with the pipeline through which the oil flows to the valve and slide valve boxes.

Side flange 4 has a finished surface and through hole 6 communicating with the gear case duct through which the oil passes from the pump. From below, the hydraulic vortex tube is closed with plug 1 which is locked with wire. The bunker is cleaned through this plug.

The operating principle of the hydraulic vortex tube is the following: under the effect of centrifugal forces mechanical impurities are thrown to the walls, from which they run down and settle in bunker 7. To impart rotary motion to the oil, oil supply hole 6 is tangential to the cylindrical surface of the vortex tube.

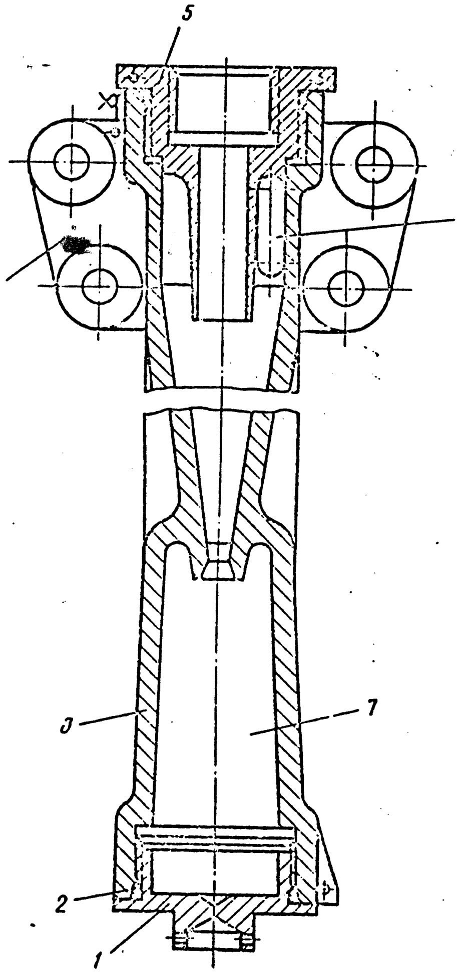

FIG.217. HYDRAULIC VORTEX TUBE

1 - drain plug; 2 - packing gasket; 3 - body of hydraulic vortex tube; attaching flange; 5 - oil outlet union to system; 6 - oval inlet hole pump; 7 - bunker

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The valve box serves to distribute the oil and to maintain the required oil pressure in the power transmission lubrication and hydraulic control system. The valve box accommodates slide valve 33 of engine clutch control system (Fig.197).

The valve box consists of body 36, valve 37 maintaining the required oil pressure in the hydraulic control system, valve 38 maintaining the required pressure in the lubrication system, engine clutch control slide valve 33 and ball non-return valve 30.

Non-return valve 30 prevents the engine clutch engagement, when the hydraulic servo-cylinders are filled during gear shifting and the oil pressure decreases for a short time.

Valves 37 and 38 represent hollow cylinders with stems 39. Valve 37 holds two concentric springs 42 and valve 38 - one spring 40.

The oil cooler is of a fin-and-tube type. It is designed to cool the oil of the power transmission lubrication and hydraulic control system.

Cooler 24 (Fig.216) is mounted in the ejector casing beside the oil cooler of the engine lubricating system. The oil cooler consists of a set of oval-section tubes, brass fins 31 fitted on the tubes, and two headers 32. Intake header 32 is divided by a partition into two spaces, and so there are two ways of oil flow in the cooler; thus, the oil path elongates, and the oil is more effectively cooled.

To protect the cooler from a surplus pressure that may be caused by oil thickening (at low temperatures), provision is made for ball by-pass valve 30 provided with a spring and adjusted for a pressure of 2.3 - 2.5 kgf/cm^2.

Smooth engagement valve, hydraulic servocylinders and slide valve box are described in the Subsections dealing with the description of the power transmission controls.

7.6.2. Operation

The operation of the power transmission lubrication and hydraulic control system is illustrated in Fig.216.

The engine drives pump 2 which feeds oil from the gear case to hydraulic vortex tube 5, and thence to valve box 12.

The oil enters space A of the valve box, presses off valve 10 of the hydraulic control system, which is adjusted for a pressure of 8 kgf/cm^2. From space A the oil flows over pipeline 34 to the slide valve box and over duct 7 to the gearbox boosters. From the slide valve box the oil passes to the hydraulic control system of the planetary steering gears and stopping brakes. A part of oil flows from space A through valve 10 to cooler 24, passes from the latter to space B and thence to the gearbox and planetary steering gears.

When the oil passes to the boosters of the hydraulic control system, its consumption increases and the pressure in space A decreases for a short time.

Actuated by a spring, valve 10 discontinues the oil flow to the planetary steering gears and gearbox, as a result, the oil consumption decreases, the pressure in space A rises, and the valve opens again.

So, the valve closes and opens intermittently, thus maintaining a constant pressure in the hydraulic control system.

Valve 8 of the lubrication system which is adjusted for a pressure of 2 - 3 kgf/cm^2 - employs the same operating principle. Space B of the valve communicates with the lubrication main; as the pressure rises above 2 - 3 kgf/cm^2, the valve opens and drains surplus oil into the gear case, thus maintaining a constant pressure in the lubrication system.

The oil path from the valve box to the gearbox boosters lies through the engine clutch control slide valve owing to which the 2nd, 3rd, 4th and 5th speed gears cannot be shifted without releasing the engine clutch.

As the engine clutch pedal is pressed, slide valve 11 displaces, and the oil flows from space A to space C of the engine clutch booster and over pipeline 35 to the gear shift boosters. Connected to non-return valve 14 is the pipeline running from the pneumatic

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system and serving to release the engine clutch when the hydraulic control system is inoperative.

When the hydraulic control system is inoperative, and the slide valves are closed, a part of oil supplied by the pump is forced through pump relief valve 30 back into the gear case.

7.6.3. Care

Care of the power transmission lubrication and hydraulic control system includes:

- watching the lubrication system oil pressure gauge;
- checking the pipeline and booster connections for attachment and tightness;
- checking the oil level in the gearbox;
- washing the hydraulic vortex tube.

Wash the hydraulic vortex tube every 4800-5000 km of run as follows:

(a) remove cover 15 (Fig.15) from the engine compartment bulkhead access hole;

(b) unscrew plug 1 (Fig.217) of the hydraulic vortex tube, and wash it in clean diesel fuel;

(c) clean the inner surface of bunker 7 with clean waste soaked in diesel fuel;

(d) screw in plug 1 and lock it with wire; before doing so, make sure that the sealing rubber ring is sound;

(e) reinstall the cover.

7.7. POSSIBLE TROUBLES AND REMEDIES

Trouble	Cause	Remedy
	Engine Clutch	
Depressing the engine clutch pedal takes much effort	Engine clutch slide valve control rods stuck	Eliminate trouble
Engine clutch pedal fails to return to initial position	Jamming in control linkage	Eliminate jamming
	Pedal return spring loose	Adjust spring tension by turning nut 43 (Fig.197)
	Engine clutch slide valve jammed	Eliminate jamming
Engine clutch slips	No clearance in release mechanism	Restore clearance (see Subsection 7.2.6)
Engine clutch fails to get released	Insufficient oil pressure in hydraulic control system (less than 1.5 kgf/cm^2)	Check oil level in gearbox, and replenish the latter, if necessary. If oil level is normal, but trouble persists, send gearbox for repair
Engine clutch is released incompletely (engine clutch drags)	Release mechanism piston jammed, and therefore pressure plate travel decreased	Send gearbox for repair
	Friction discs warped	Send gearbox for repair
	Gearbox	
Gears are shifted with difficulty or fail to get shifted at all	Insufficient oil pressure in hydraulic control system	Check oil level in gearbox, and replenish the latter, if necessary. If oil level is normal, but trouble persists,

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Continued

Trouble	Cause	Remedy
		send gearbox for repair
	Engine clutch incompletely released	Send gearbox for repair
	Synchronizer cones worn out	Send gearbox for repair
Spontaneous disengagement of gears	Gearbox control linkage out of adjustment, and therefore gears fails to get engaged completely	Adjust gearbox control linkage (see Subsection 7.3.4)

Final Drive

Overheating	Insufficient amount of oil in final drive (oil does not pour out of level hole of housing)	Replenish final drive till oil appears in level hole
	Bearings damaged	Send final drive for repair
Oil leakage through driving sprocket packing	Packing of driven shaft of final drive worn out	Remove final drive and replace packing
Oil leakage through speedometer drive packing	Rubber cup worn out	Remove final drive and replac rubber cup
Knocking	Teeth on gears of planetary gear set broken	Remove final drive and replac components of planetary gear set

Stopping Brakes

During straight-forward movement brake band overheats	Clearance between stopping brake drum and band too small or absent at all	Adjust clearance between ban and drum (see Subsection 7.4.5
As steering handle bar is turned to either extreme position, no sharp turn of vehicle is caused, and lagging track is not stopped	Stopping brake bands fail to get tightened	Adjust clearance between band and drum
As brake pedal is depressed, vehicle keeps moving or turns	One or both brake bands fail to get tightened	Adjust clearance between ban and drum
When stopping brake control handle is pulled to extreme position on upgrade, vehicle rolls down	Left-hand stopping brake band fails to get tightened	Adjust clearance between ban and drum of left-hand brake Adjust stopping brake contro linkage

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8. RUNNING GEAR

8.1. COMPOSITION

The running gear of the vehicle consists of a caterpillar drive and a suspension.

8.2. CATERPILLAR DRIVE

8.2.1. General

The caterpillar drive is designed to transform the rotary motion of the driving sprockets into the progressive motion of the vehicle. It ensures a high cross-country capacity of the vehicle due to low specific ground pressure.

The caterpillar drive (Fig.218) consists of two tracks 24, two driving sprockets 31, two idler wheels 18 with track adjusting mechanisms, twelve road wheels 27 and six support rollers 17, as well as two cleaners 20.

8.2.2. Tracks

Each track (Fig.219) consists of 84 small-size track shoes which are hinge-joined by means of rubber-covered pins. Track shoes 1 are stamped pieces; they have welded ridges 3 and two long eyes at the edges. The smooth upper surface of the track shoes serves as the bearing race for the road wheels.

Ridges 3 prevent the track from going off the road wheels and support rollers. The track shoe outer surfaces have grousers 9 serving to improve track adhesion.

Pressed in the track shoe eyes are two pins 5 bearing six rubber-vulcanized bushings 2. The pins are cylindrical in shape with flats 8 at the ends.

Shackles 6 fitted on the ends of the pins of two neighbouring track shoes, serve for joining the latter.

Flats 8 are so positioned, that upon installation of wedge 7 and tightening of nut 4, a preliminary angle of bend (15°) is formed between the track shoes, with its apex facing up.

As the track moves over the wheels and sprockets, and one track shoe turns relative to another, and as the track shoes are under the road wheels, the rubber bushings are twisted within the limits of this angle; this prevents premature wear of the rubber. Shackles 6 are secured with wedges 7 inserted in the latter from below and engaged with pin flats 8 through their bevels. The threaded portion of the wedges enters the hole of shackle 6 and holds self-locking nut 4. The nut is held in place due to resilience of the taper portion provided with four vertical slots and reduced to a smaller diameter.

Upon pressing in, rubber bushings 2 fill up the clearance between the pin and eye and thus prevent ingress of moisture and abrasive. One track shoe turns relative to another due to twisting of rubber; so there is no friction between the metal parts, and operation of the track shoes is more reliable.

The upper run of the track is closed with fenders from the side, with front guards at the front, and with guide vanes (improving the vehicle performance on water) at the rear.

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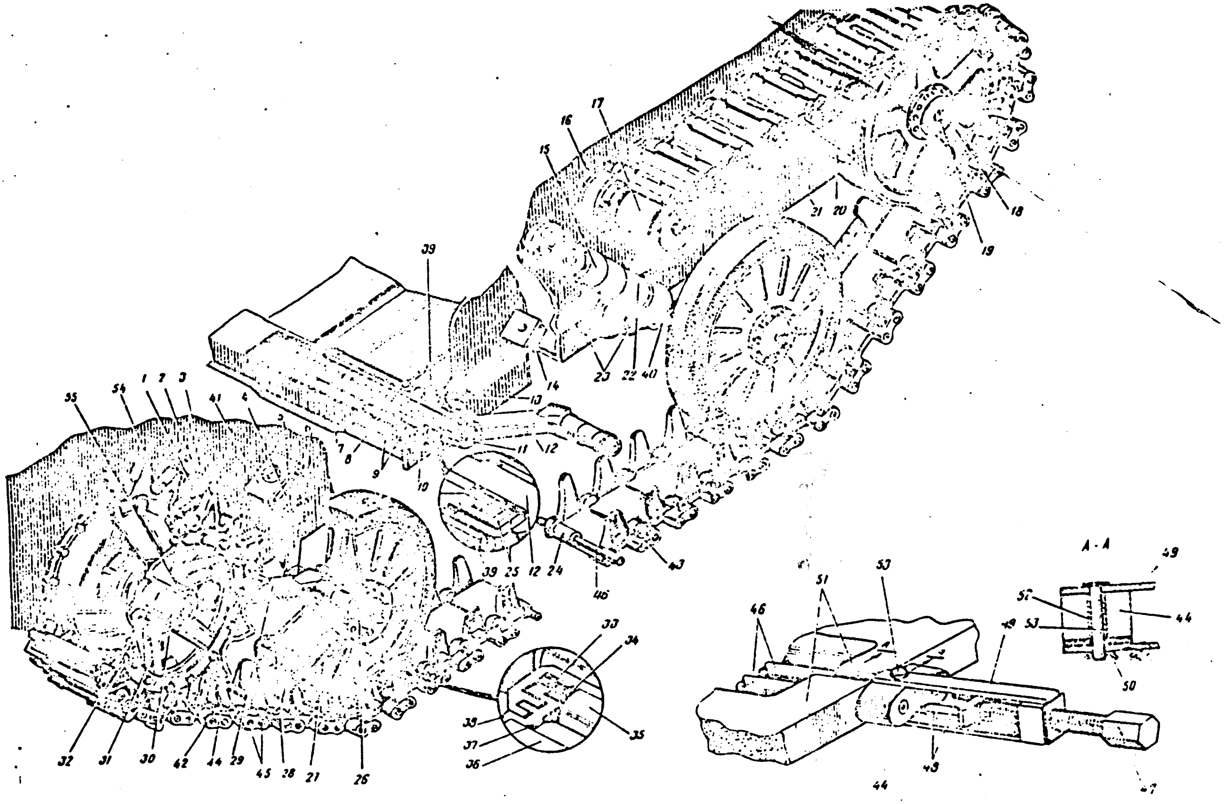

FIG.218. RUNNING GEAR

1 - upper head of front shock absorber; 2 - filler hole plug; 3 - driving sprocket toothed rim; 4 - spring stop; 5 - limiter strip; 6 - side stop; 7 - bushing of road wheel arm axle; 8 - filler hole plug; 9 - torsion bars; 10 - large bushings of road wheel arm axles; 11 - torsion bar hole cap; 12 - road wheel arm; 13 - lubrication hole plug of road wheel arm bushing; 14 - rubber stop; 15 - - hydraulic shock absorber; 16 - hull side; 17 - support roller; 18 - idler wheel; 19 - filler hole plug; 20 - - cleaner; 21 - cleaner securing bolt; 22 - shock absorber filler hole plug; 23 - torsion bar bolts; 24 - tracks;

25 - shims; 26 - nut of road wheel axle; 27 - road wheel; 28 - road wheel rubber tyre; 29 - front road wheel arm; 30 - driving sprocket attaching plug; 31 - driving sprocket; 32 - final drive carrier shaft; 33 - labyrinth seal cover; 34 - cup; 35 - roller bearing; 36 - road wheel hub; 37 - rubber ring; 38 - labyrinth seal holder; 39 - suspension bracket; 40 - arm; 41 - bracket; 42 - wedge nut; 43 - shackle wedge; 44 - shackle; 45 - holes in track pins; 46 - track pins; 47 - remover screw; 48 - stops; 49 - cheek; 50 - cotter pin; 51 - track shoes; 52 - bushing; 53 - remover shaft; 54 - rim attaching bolt; 55 - locking bolt of driving sprocket plug

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8.2.3. Driving Sprockets

The cast driving sprockets (Fig.220) are welded of two parts: disc 4 and splined hub 6. They are installed on shafts 7 of the final drives in the front portion of the vehicle.

Secured to the flanges of the discs and hubs of the driving sprockets by means of bolts 5 are toothed rims 3 having fourteen teeth each.

To increase wear-resistance of the teeth a layer of hard alloy is welded on the teeth working surfaces. The driving sprocket is fixed against axial displacement by plug 11 which is retained with two bolts 8 having locking washers.

8.2.4. Idler Wheels

The idler wheels (Fig.221) with steel rims revolve on ball bearing 1 and roller bearing 10 which are fitted on axles 32 made integral with the cranks. The wheels are mounted at the vehicle rear. The idler wheel is welded of two shaped discs 7 consisting of a hub, five spokes and rims. Ribs 8 welded between the discs improve the wheel rigidity. The wheel is held against axial displacement by round nut 3 which is locked with retainer 5.

The idler wheel is packed with the use of labyrinth seal 12 and twin self-tightening cup 11 mounted in cover 27, as well as by sealing rings.

A threaded hole provided in front cover 2 and closed with plug 4 having a fibre gasket, serves for filling the idler wheel hub with oil. Secured in front of the idler wheels on the vehicle hull by means of bolts 21 (Fig.218) are cleaners 20. The latter may displace to ensure better cleaning of the idler wheels. For this purpose, the cleaner guide has slots for the square heads of the securing bolts to move.

8.2.5. Track Adjusting Mechanism

The track adjusting mechanism consists of crank 13 (Fig.221), track adjusting mechanism body 25, neck 26, worm 18, worm wheel 17 and a locking device.

The crank rests with its axle 31 on two bronze bushings 23 mounted in body 25 and neck 26. The body is cast; it is welded to the side plate from the outside, and the neck is attached from the inside with the help of bolts 33. Locking toothed coupling 19 fitted on the splines of the crank axle is engaged by its end teeth with the teeth of body 25 and held against axial displacement by round nut 22. The nut is retained by locking plate 21 and bolt 20. Worm 18 is mounted on two bronze bushings 23 in the boss of body 25. The worm shaft has a hexahedral head to receive a wrench. Worm wheel 17 fitted on the splines of crank axle 31 is meshed with the worm. The wheel is held against axial displacement by locking ring 24.

The mechanism is filled with lubricant through a hole closed with a plug. The mechanism is packed with self-tightening cup 28 mounted in neck 26.

To change the track tension, unscrew bolt 20, remove locking plate 21 and turn off nut 22; disengage toothed coupling 19. Then, turning the hexahedral head of worm 18, obtain the necessary tension.

Rotation of the worm causes worm wheel 17 and crank axle 31 to rotate too, thus moving idler wheel axle 32 closer or farther from the driving sprocket axle and changing the track tension.

8.2.6. Support Rollers

The single support rollers (Fig.222) are made of aluminum alloy and fitted with rubber tyres. They revolve on two ball bearings 11 fitted on axles 13 of brackets 2 which are attached with bolts 16 to the side plates of the hull. The support roller is held against axial displacement by round nut 5 which is fixed with lockpin 7. From the outside, the roller hub is closed with cover 8 holding plug 9 with a fibre gasket in its centre. The plug hole serves for filling in oil.

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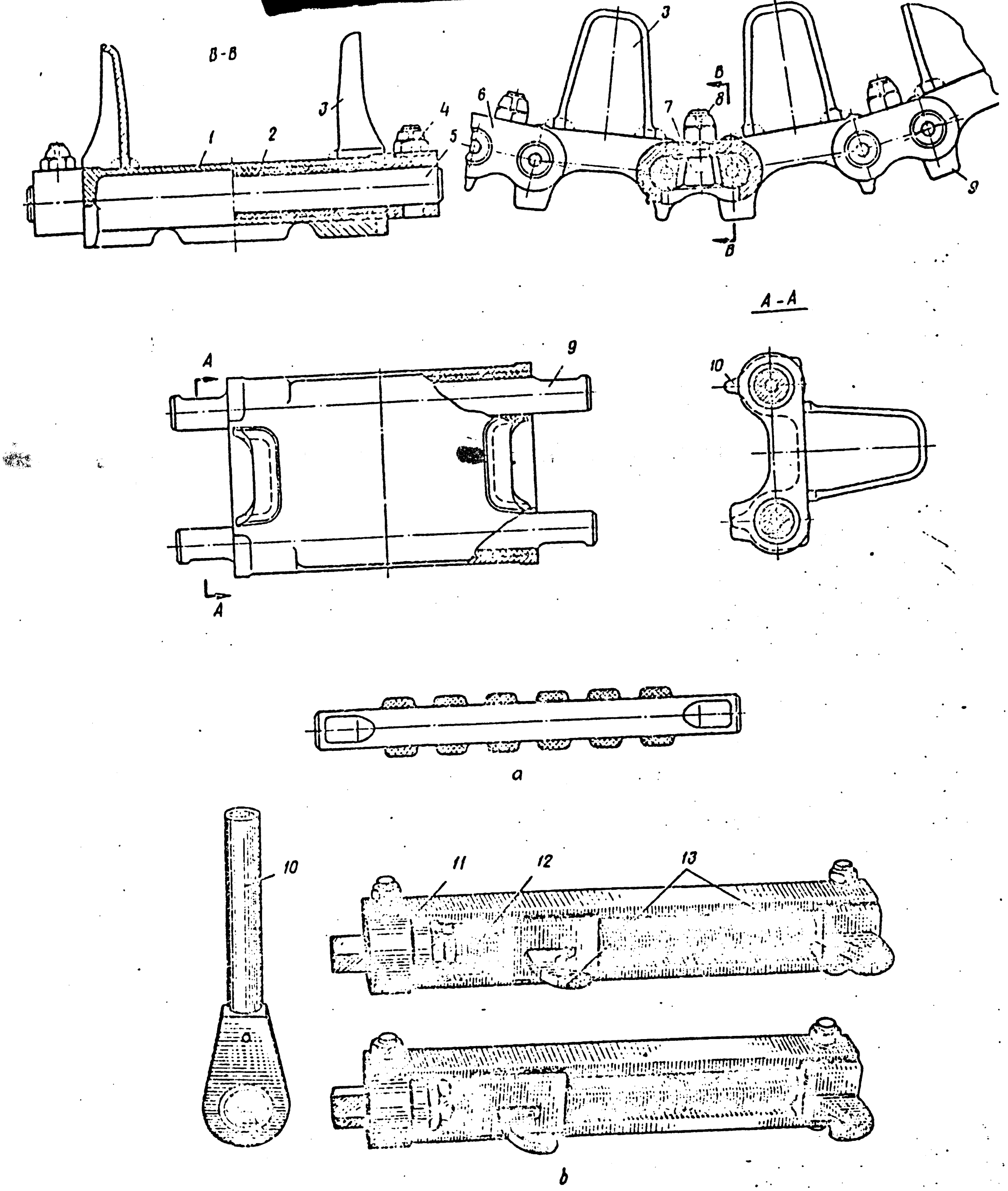
B-B
1
2
3
4
5
6
7
8
9
B
B
A-A
A
A
10
a
10
11
12
13
b

FIG.219. TRACK

a - track; b - device for pulling track ends

1 - track shoe; 2 - rubber bushing; 3 - ridge; 4 - wedge nut; 5 - track pin; 6 - shackle; 7 - wedge; 8 - flat on pin; 9 - grousor; 10 - ratchet wrench; 11 - body; 12 - screw; 13 - catches

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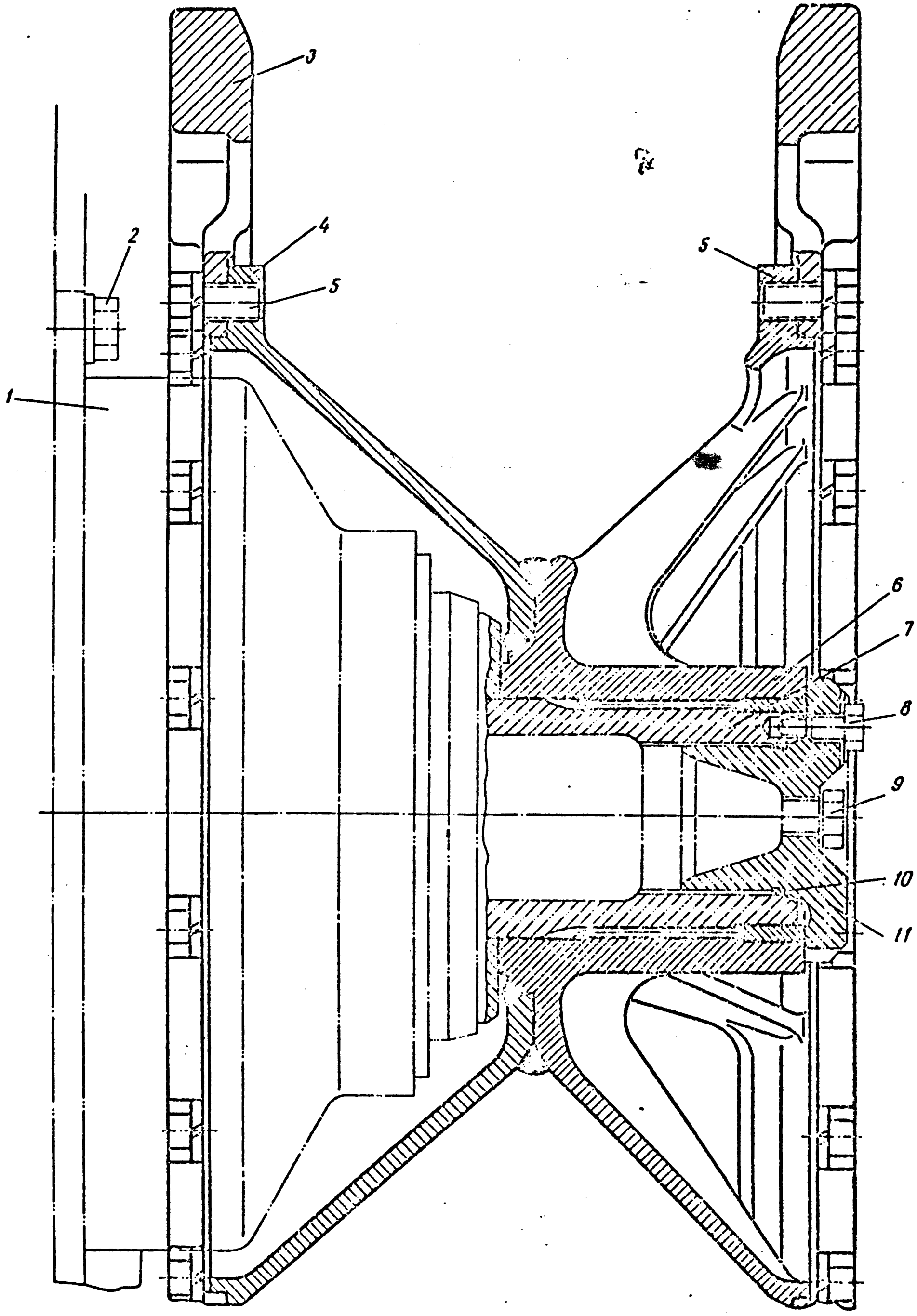

FIG. 220. DRIVING SPROCKET

1 - final drive; 2 - final drive housing attaching bolt; 3 - driving sprocket toothed rim; 4 - disc; 5 - toothed rim attaching bolt; 6 - driving sprocket hub; 7 - shaft of final drive carrier; 8 - plug fastening bolt; 9 - filler hole plug; 10 - packing ring; 11 - driving sprocket attaching plug

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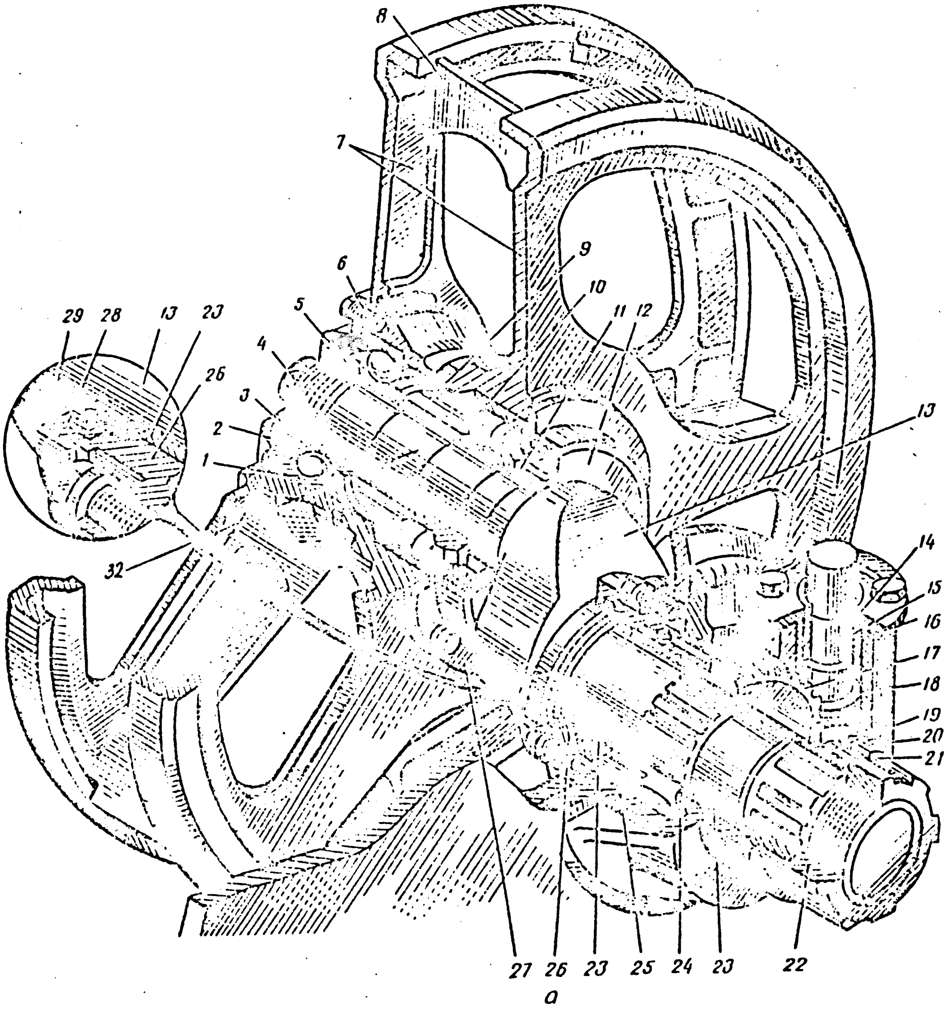
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FIG.221. IDLER WHEEL WITH

a - idler wheel;

1 - ball bearing; 2 - cover; 3 - nut; 4 - plug; 5 - nut retainer; 6 - cover attaching bolt; 7 - wheel discs; 8 - stiffening rib; 9 - distance piece; 10 - roller bearing; 11 - cup; 12 - labyrinth seal; 13 - crank; 14 - worm bushing; 15 - flange; 16 - shims; 17 - worm

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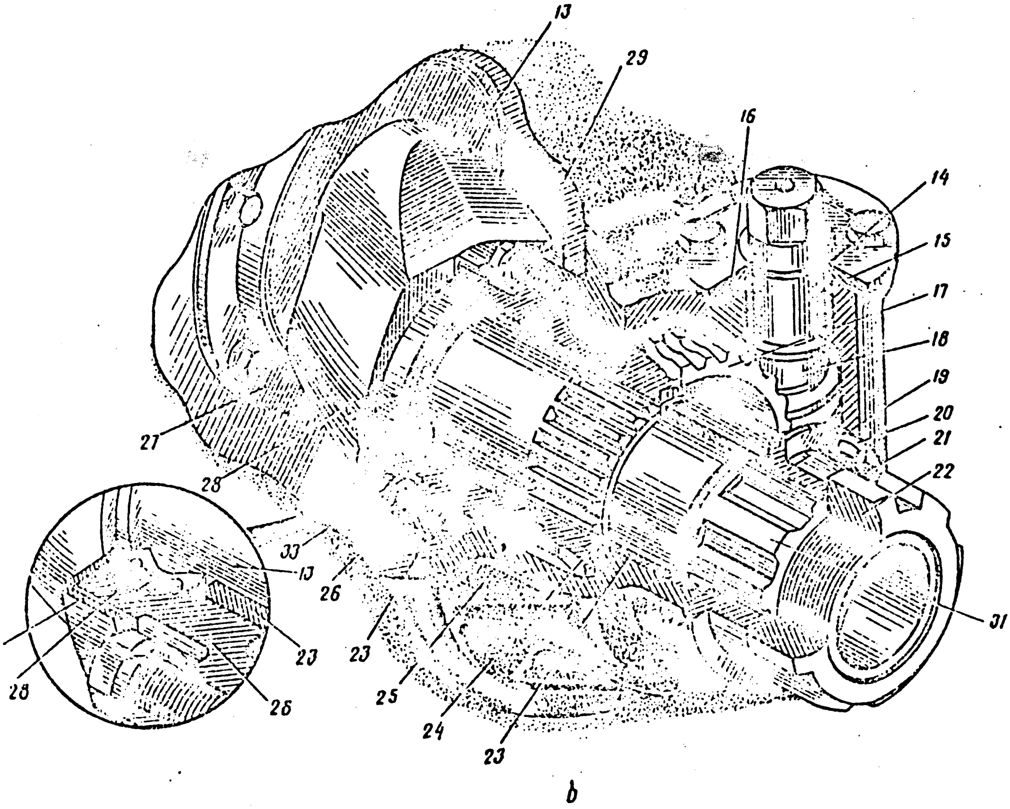
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TRACK ADJUSTING MECHANISM

b - track adjusting mechanism

wheel, 18 - worm; 19 - toothed coupling; 20 - locking plate fastening bolt; 21 - nut locking plate; 22 - crank attaching nut; 23 - crank axle bushing; 24 - thrust ring; 25 - track adjusting mechanism body, 26 - housing neck; 27 - labyrinth seal cover; 28 - spring-loaded cup; 29 - hull side; 30 - cup holder; 31 - crank axle; 32 - idler wheel axle; 33 - bolt

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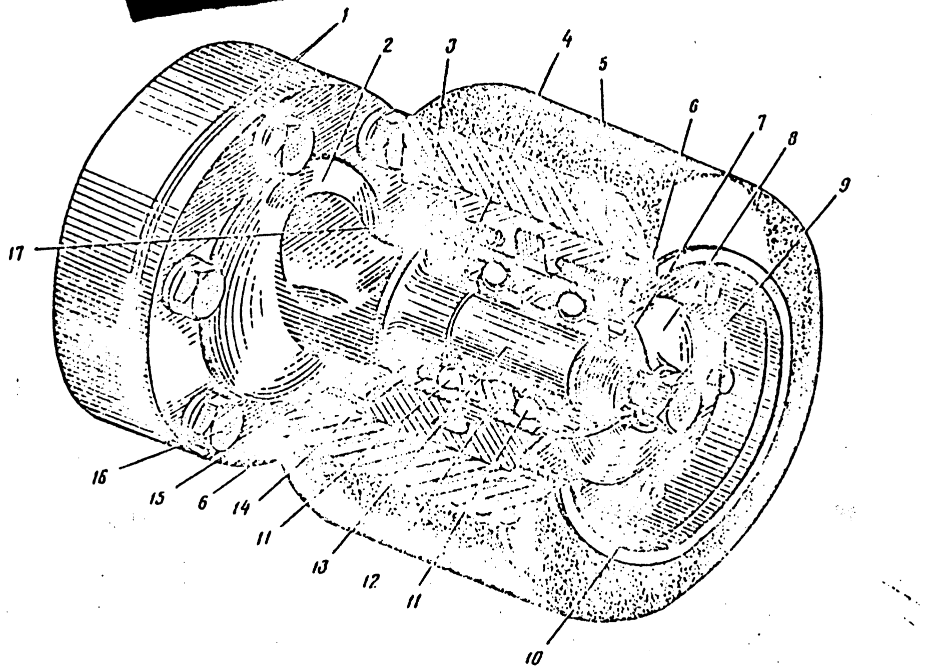

FIG.222. SUPPORT ROLLER

1 - shims; 2 - roller bracket; 3 - hub; 4 - rear cover; 5 - roller attaching nut; 6 - hub ribs; 7 - nut lockpin, 8 - cover; 9 - filler hole plug; 10 - cover attaching bolt; 11 - ball bearing; 12 - distance piece; 13 - roller axle; 14 - spring-loaded cup; 15 - labyrinth seal; 16 - bracket attaching bolt; 17 - cover attaching bolt

The space of the support roller is packed with labyrinth seal 15 and self-tightening cup 14 mounted in rear cover 4 which is attached with bolts 17 to roller hub 3.

8.2.7. Road Wheels

The single road wheels (Fig.223) represent hollow drums consisting of hub 34, two discs 9 and steel rim 10 welded together. Vulcanized to the rims are rubber tyres 11. The road wheel is mounted on axle 3 made integral with road wheel arm 12; the road wheel revolves on ball bearing 1 and roller bearing 35. The road wheel is held against axial displacement by nut 2 which is retained in position with lockpin 4. From the outside, the hub is closed with blind cover 7; a filler hole made in the centre of the cover is closed with plug 5; from the inside, the hub is closed with rear cover 32 holding self-tightening cup 30. A projection made on the cover face enters the slot of labyrinth seal holder 31 mounted on the road wheel arm. Front cover 7 is packed with rubber ring 8 and minium. The bearings of the road wheel are lubricated with oil МТ-16п which is filled up to the lower edge of the filler hole.

8.3. SUSPENSION

8.3.1. General

The suspension damps the shocks and jolts imparted from the road wheels to the tank hull during movement over uneven roads or cross-country. It also prevents hull swinging and thus

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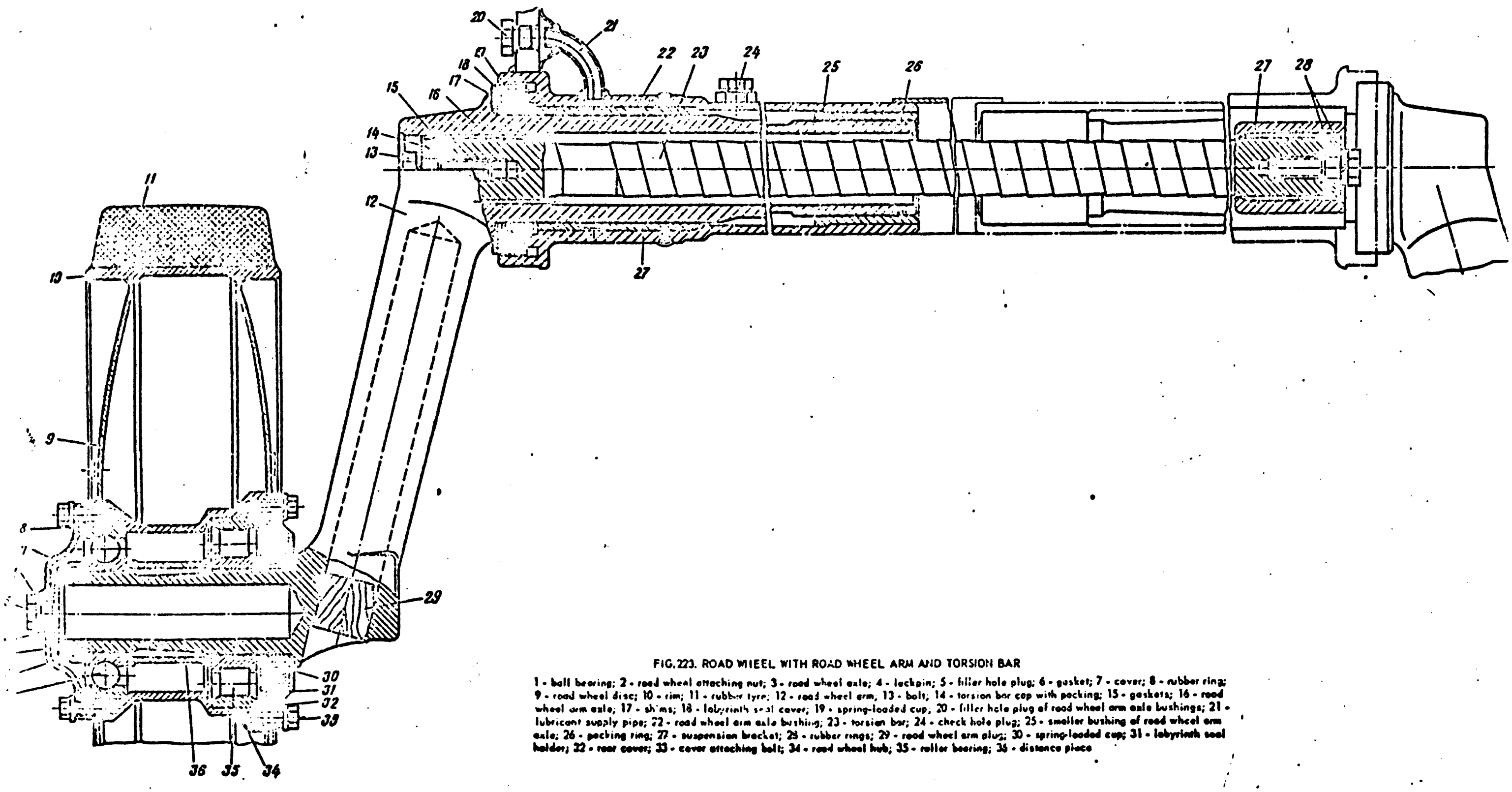

FIG.223. ROAD WIEEL WITH ROAD WHEEL ARM AND TORSION BAR

1 - ball bearing; 2 - road wheel attaching nut; 3 - road wheel axle; 4 - lockpin; 5 - filler hole plug; 6 - gasket; 7 - cover; 8 - rubber ring; 9 - road wheel disc; 10 - rim; 11 - rubber tyre; 12 - road wheel arm; 13 - bolt; 14 - torsion bar cap with packing; 15 - gaskets; 16 - road wheel arm axle; 17 - shims; 18 - labyrinth seal cover; 19 - spring-loaded cup; 20 - filler hole plug of road wheel arm axle bushings; 21 - lubricant supply pipe; 22 - road wheel arm axle bushing; 23 - torsion bar; 24 - check hole plug; 25 - smaller bushing of road wheel arm axle; 26 - packing ring; 27 - suspension bracket; 28 - rubber rings; 29 - road wheel arm plug; 30 - spring-loaded cup; 31 - labyrinth seal holder; 32 - rear cover; 33 - cover attaching bolt; 34 - road wheel hub; 35 - roller bearing; 36 - distance piece

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and, consequently, improves the operating conditions for the crew.

The suspension is of an independent torsional type provided with hydraulic shock absorbers. It consists of twelve torsion bars 9 (Fig.218), twelve road wheel arms 12 mounted in suspension brackets 39, four rubber stops 14, four spring stops 4 and four hydraulic shock absorbers 15.

8.3.2. Road Wheel Arm

The road wheel arm (Fig.223) is forged of steel. It is made integral with the road wheel arm axle and road wheel axle. The road wheel arm rod, road wheel axle 3 and road wheel arm axle 16 are hollow. Inserted in the road wheel arm hole from below is wooden plug 29. Labyrinth seal holder 31 press-fitted on road wheel axle 3 together with rear cover 32 of the road wheel forms a labyrinth. Triangular splines cut inside the road wheel arm axle are engaged with the splines of torsion bar 23.

The road wheel arm axle rests on two bushings 22 and 25 that are pressed into the holes of suspension bracket 27. The brackets of the suspension consist of two forged halves and welded to the side plate and bottom of the vehicle. Brackets 27 have through shaped holes to receive the road wheel arm bushings, and one splined hole to receive the smaller head of the torsion bars. On its outer surface bracket 27 has a boring to hold cup 19 and a groove to receive the edge of cover 18; the cover and the cup make up a labyrinth. The road wheel arm bushings are lubricated through a threaded hole made in the side plate of the hull and closed by plug 20; the hole communicates with the filler hole of the road wheel arm through pipe 21.

Unlike the middle road wheel arms, the front and the rear road wheel arms have eyes 40 (Fig.218) to connect the hydraulic shock absorbers. The rear road wheel arms have smaller weight due to a larger diameter of the hole in the road wheel arm rod.

8.3.3. Torsion Bar

Torsion bar 23 (Fig.223) is a long solid cylindrical rod whose ends are provided with splined heads. The larger head of torsion bar 23 engages the splines of road wheel arm axle 16, and the smaller head enters the hole of suspension bracket 27. To protect the torsion bar from corrosion and mechanical damage, the torsion bar rod is coated with primer and paint and wrapped in two layers of rubberized insulating tape; from the outside, it is coated with bakelite varnish.

The torsion bar is held against axial displacement by caps 14 mounted in the road wheel arm axle and the suspension bracket, as well as by bolts 13 screwed in the threaded hole of the torsion bar. The caps are packed by rubber rings 28. The threaded hole in the larger head of the torsion bar is used also for pulling the torsion bar from the vehicle. To increase the fatigue resistance of the torsion bars, the latter are subjected to preliminary twisting in the direction of their operation; therefore, the torsion bars are divided into left-hand and right-hand bars bearing the respective marking: LEFT (ЛЕВ.) and RIGHT (ПР.). While installing the torsion bars, observe the marking.

8.3.4. Road Wheel Arm Stops

The road wheel arm stops serve to limit the travel of the road wheel arms, as well as the additional resilient elements improving the suspension performance. Installed over the front and rear road wheels are spring stops 4 (Fig.218), and over the second and fourth road wheels, rubber stops 14. The spring stop represents a buffer spring welded to the base. At great angles of twist the road wheel arm strikes against the stem inserted in the spring from below. The stop is attached to the bracket welded to the hull side with a bolt; the latter is fixed with a locking washer.

[redacted]

To prevent bending of the road wheel arm in case the road wheels strike heavily agai obstacles, shaped limiter strips 5 are welded to the hull sides behind the front road whe Side stops 6 of the road wheel arms slide over these strips in case of blows.

Rubber stops 16 are actually rubber pads vulcanized to the base which is attached by of a bolt with spring washer to the bracket welded to the hull side.

8.3.5. Hydraulic Shock Absorbers

The hydraulic shock absorbers (Fig.224) serve to damp oscillations of the vehicle du movement over uneven terrain and roads. The principle of operation of the hydraulic shock absorber is based on conversion of the kinetic energy of the vehicle oscillations into th energy of the fluid flowing through holes having a restricted passage area. The vehicle i equipped with four hydraulic shock absorbers (one per each of the front and rear units of suspension).

The hydraulic shock absorber is of a telescopic double-acting type; it consists of body 11, packing body 13 screwed into one end of the latter, and eye 33 screwed into the end. Body 11 houses cylinder 10 resting on the boring of the eye and the boring of suppo The cylinder is packed with rubber rings 23. The space between body 11 and cylinder 10 i compensation chamber 28.

Piston 27 moving inside the cylinder has a rod whose end holds screwed-in upper eye 19 made integral with the cover. It is fixed with lockpin 34. Screwed on the thread of t cover is casing 16 being fixed by locking plate 17. The rod of piston 27 is packed with packing 14 (a set of sealing rings and cups) and fluoroplastic gaskets placed between th rings and cups. The packing is pressed with eight springs 35 located in the borings of bushing 36. Piston 27 accommodates compression valve 8, bushing with throttle hole 29, a rebound valve 7. The piston is sealed with spring rings 6. Lower eye 33 mounts valve 30 designed to discharge excessive fluid from the working space into the compensation chamb during compression (downward) stroke of the piston. The volume of the space over the pis other than the space under the piston, since the former accommodates the piston rod. The hole of lower eye 33 holds intake valve 2 which serves to replenish the working space of cylinder 10 with working fluid from compensation chamber 28 during rebound (upward) stro of the piston. Bushing 36 seated in support 12 serves as a guide for the piston rod. The piston rod is sealed in the bushing by rubber cup 37 which prevents working fluid flow f the working space of the cylinder into the compensation chamber during the rebound strok the piston.

The joint of shock absorber body 11 with packing body 13 and upper eye 19 is seale means of rubber rings. The body bears a welded boss which has a threaded filler hole cl with plug 24.

The amount of fluid filled into the hydraulic shock absorber is 840 cm^3. Fluid is up to the level of the filler hole.

The working fluid of the shock absorber is a mixture of turbine oil (50%) and tran oil (50%).

The hydraulic shock absorber operates as follows (Fig.225). When running over an o the road wheel rises, and the road wheel arm displaces the shock absorber body connecte lower eye 33 of the road wheel arm through a hinge joint.

If the rate of road wheel travel is not high, the rate of travel of piston 27 in c der 10 is also not high, and, therefore, the working fluid flows from space A under the to space B over the piston through calibrated hole 25 of the piston and to compensatio 28 through throttle hole 29 in the flange of lower eye 33. As the working fluid flowin the narrow holes encounters resistance, the energy of the hull oscillations is convert the thermal energy of the fluid, and thus the oscillations are damped.

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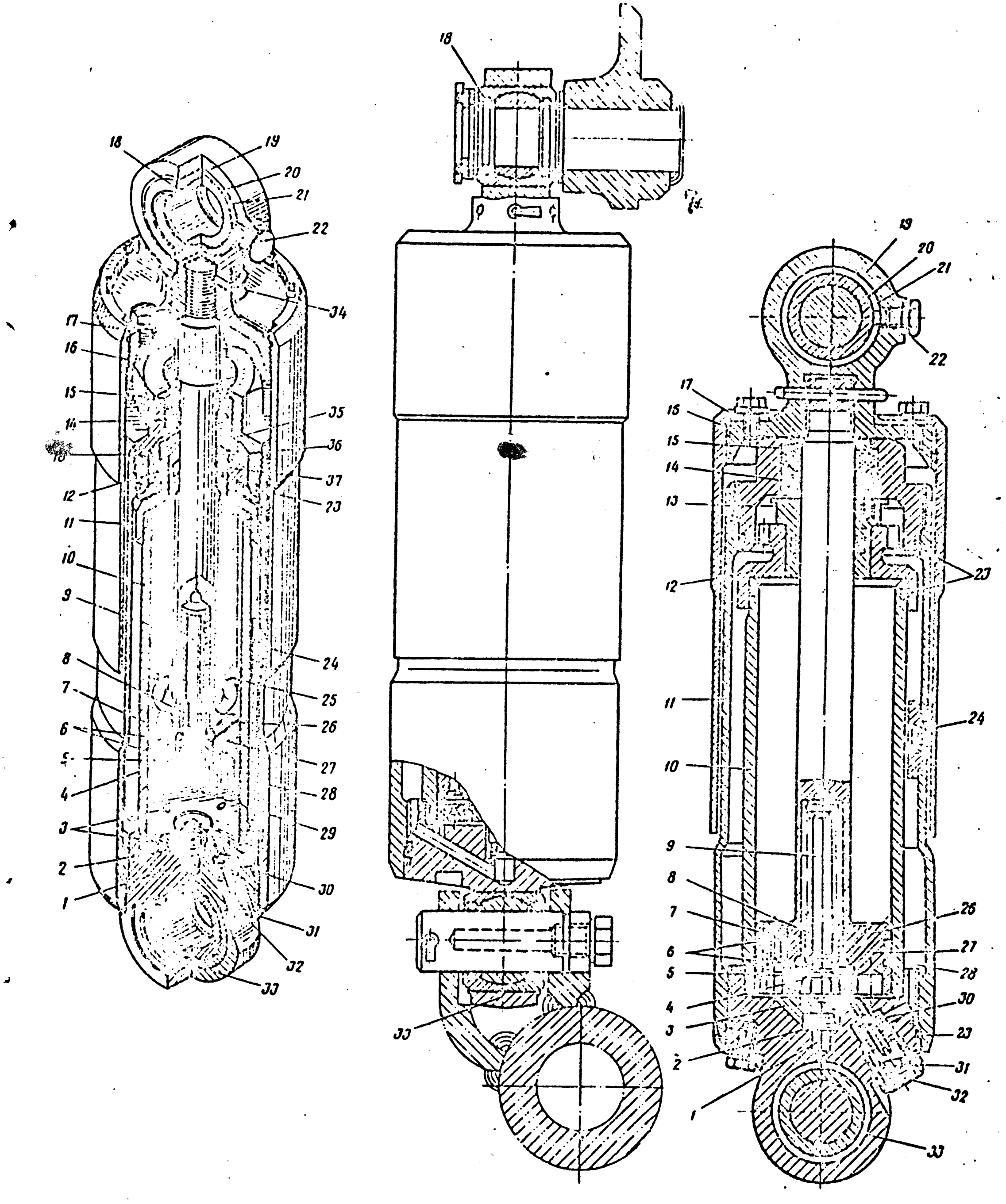
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FIG.224. HYDRAULIC SHOCK ABSORBER

1 - intake valve duct; 2 - intake valve; 3 - duct, 4 - rebound valve seat; 5 - adjusting washers; 6 - packing spring rings; 7 - rebound valve, 8 - compression valve, 9 - valve guide; 10 - operating cylinder, 11 - shock absorber body, 12 - support, 13 - packing body, 14 - packing, 15 - packing washer, 16 - shock absorber casing, 17 - locking plate, 18 - rubber packing ring, 19 - upper eye, 20 - spherical bushing, 21 - bushing, 22 - filler hole plug, 23 - sealing ring, 24 - filler hole plug, 25 - calibrated hole; 26 - duct for passage of fluid from under-piston space A to above-piston space B, 27 - piston, 28 - compensation chamber, 29 - throttle hole, 30 - by-pass valve, 31 - valve plug, 32 - shims, 33 - lower eye, 34 - lockpin, 35 - packing spring, 36 - bushing; 37 - rubber cup

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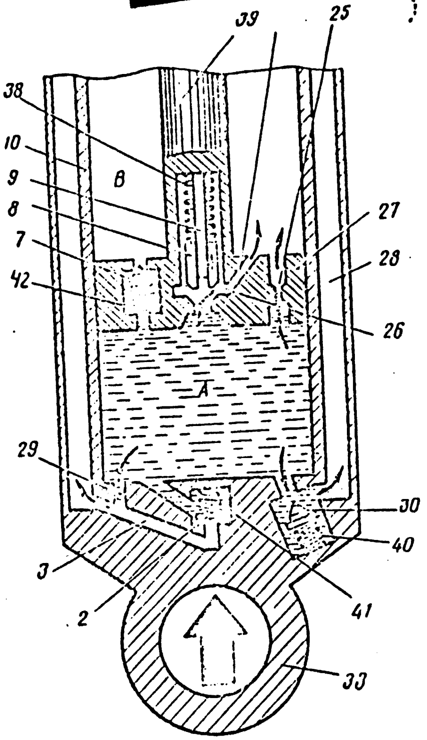

FIG.225. DIAGRAM OF SHOCK ABSORBER OPERATION

(Ref. Nos are same as in Fig.224)

38 - compression valve spring; 39 - piston rod; 40 - by-pass valve spring; 41 - intake valve spring; 42 - rebound valve spring
A and B - spaces

As the vehicle overcomes the obstacle, the road wheel moves down and the road wheel arm pulls working cylinder 10. The volume of the space under the piston increases, and that of the space over the piston, decreases; the increase in volume of space A under the piston is larger than the decrease in volume of space B above the piston; the difference between them is the volume of piston rod 39. If the road wheel runs down the obstacle smoothly, the fluid flows through calibrated hole 25 of the piston and from compensation chamber 28 to space A under the piston through throttle hole 29 of lower eye 33.

When the vehicle moves over cross-country at a high speed, the road wheels move up and down quickly. When the road wheel and cylinder 10 rise quickly, the working fluid has no time to pass through calibrated hole 25 of the piston, and the pressure in space A under the piston rises and opens compression valve 8; oil overcomes the effort of spring 38 and flows through this valve from space A under the piston to space B over the piston, and excessive oil (produced as a result of difference in the volumes of the spaces over and under the piston) passes through valve 30 in lower eye 33 into the compensation chamber, overcoming the spring effort.

When the road wheel quickly lowers together with the road wheel arm and hydraulic shock absorber cylinder 10, the pressure in space B over the piston rises and opens rebound valve 7; the oil flows to space A under the piston, overcoming the effort of spring 42.

As the volume of the vacancy formed under the piston exceeds the volume of the incoming oil (the difference is the volume of piston rod 39), the oil flows from compensation chamber 2 through intake valve 2 (overcoming the effort of spring 41) to space A under the piston, thus replenishing it.

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The reserve working fluid contained in the compensation chamber is designed to compensate for the losses in the form of a film on the rod surface.

8.4. CARE OF RUNNING GEAR

8.4.1. General

Care of the running gear includes daily inspection of the track shoe shackles, wedges and nuts; cleaning of the guide vanes; checking the tightening of the track shoe wedge nuts; checking and adjustment of track tension; checking of the working fluid level in the shock absorbers, lubrication of the road wheel arm axle bushings; checking and replenishing the road wheels and support rollers, idler wheels and track adjusting mechanisms; lubrication of the shock absorber upper supports; checking the tightening of the driving sprocket plugs and rim securing bolts.

8.4.2. Adjusting the Track Tension

Check the track tension every 1200-1300 km of run and adjust it, when required, as follows.

(a) Place the vehicle on a level hard ground (the brakes must be released).

(b) Raise and lock the fenders.

(c) Unlock the idler wheel crank (See Para. 8.2.4).

(d) Insert two dowels in the holes of the pins of the track shoes lying on the rims of the first and second support rollers, and insert the third dowel in the hole of the track shoe positioned in the middle of the distance between the first and second support rollers. Stretch the thread between the extreme dowels.

(e) Rotate worm 18 (Fig. 221) of the track adjusting mechanism till the track deflection measured between the middle dowel and the thread is within 6 to 8 mm; engage toothed coupling 19 with the teeth of the track adjusting mechanism body.

(f) Lock the crank. Turn the worm in the reverse direction so as to relieve it.

(g) If the track cannot be adjusted as required, remove one shoe from each track.

8.4.3. Removing the Track Shoe

To remove the track shoe, proceed as follows.

(a) Loosen securing bolts 21 (Fig. 218) of cleaner 20 and move the latter to the maximum possible distance from the rim of idler wheel 18.

(b) Tighten up cleaner securing bolts 21.

(c) Unlock the idler wheel crank; rotate the worm of the track adjusting mechanism so as to obtain the maximum deflection of the track.

(d) Unscrew four securing nuts 42 of the shackle wedges on the front sloping run of the track between the driving sprocket and the first road wheel.

(e) Knock out four wedges 43.

(f) Remove dirt from both ends of hole 45 of the pins of the track shoe to be dismantled and of the neighbouring track shoes to a depth of 5 to 10 mm.

(g) Uncotter the shaft and take it out of the shackle puller and dismount bushing 52.

(h) Insert bushing 52 of the shackle puller in the hole for wedge 43, then connect the puller with the shackle by shaft 53 and cotter the latter.

(i) Insert stops 48 of the puller in holes 45 of the track shoe pins and rotate puller screw 47 by a ratchet wrench till the shackle to be removed is displaced to the ends of the pins.

After that, using the same puller, remove the opposite shackle, and then dismount the shackle located on the pin ends.

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Remove the other two shackles in the same order.

ATTENTION. If the efforts of one man are insufficient for removing the shackle, strike at the end face of the puller cheek and on the shackle by a hammer. Each time the shackle is jammed, repeat the entire operation.

(j) Join the track ends between the driving sprocket and the front road wheel with the aid of two coupling devices, for which purpose fit their grips on the pins of the track shoes to be coupled. Turn the screws of the coupling devices with the use of a ratchet wrench till the shackles can be mounted on the pins of the track shoes to be connected.

To avoid misalignment and disengagement of the coupling devices from the pins of the track shoes, tighten the track evenly by successively turning the screws of the coupling devices.

(k) Fit the shackles on the pins of the track shoes to be joined by tapping on them with a hammer, and then remove the coupling devices and finally mount the shackles.

(l) Insert the wedges in the shackles and screw nuts on them without tightening.

(m) Place a templet (wedge) under the front road wheel on the driving sprocket side. The use of a templet makes it possible to arrange the track shoes to be joined at an angle of 15° and thus to ensure proper contact between the flats of the pins and wedge, and so to provide reliable tightening.

(n) Start the engine and slowly move the vehicle forward so as to shift the newly-made joint of the track under the templet. Stop the engine and finally tighten the wedge nuts applying an effort of 35 kgf on a 400-mm long arm.

(o) Start the engine, move the vehicle backward, stop the engine and remove the templet. If no templet is available (in the field conditions), tighten up the track wedges on the idler wheel for a certain period of time, and afterwards retighten the track with the use of a templet.

(p) Tighten up the tracks and lock the idler wheel crank.

(q) In winter time set the idler wheel cleaner to a distance of 3 to 5 mm from the idler wheel rim.

(r) Lower the fenders and secure them with bolts.

8.4.4. Replacing the Tracks

Replace the tracks when removal of one track shoe cannot help to adjust the track by means of the track adjusting mechanism.

A new track should have 84 shoes.

Replace the tracks as follows:

(a) Place the vehicle on a level ground.

(b) Uncouple the track (see removal of a track shoe).

(c) Remove the track from the driving sprockets and from the support rollers and place it behind the vehicle.

(d) Put a new track in front of the vehicle.

(e) Drive the vehicle by the road wheels on the track, tucking the latter under the wheels by means of a crowbar.

Drive the vehicle in the first gear till two or three track shoes are left in front of the first road wheel. If both tracks have been removed from the vehicle, drive the vehicle onto new tracks with the use of a tractor.

(f) Brake the vehicle by the parking brake and shut down the engine.

(g) Secure one end of a wire rope to the protruding ends of the pins of the track shoe which is the last at the vehicle rear, tighten the wire rope and pass it between the rims of the idler wheel, then pull it over the support rollers to the driving sprocket and wind on the hub of the latter (make three or four turns).

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(h) Start the engine.

(i) Turn the steering handle bar in the direction opposite to the side on which the track is mounted.

(j) Release the parking brake handle.

(k) Shift into the first gear and gradually tighten the track. At the moment the top run of the track is tightened, depress the stopping brake pedal, quickly shift into neutral and turn the steering handle bar to a neutral position.

(l) Stop the vehicle by the parking brake.

(m) Shut down the engine.

(n) Remove the wire rope from the track shoe pin and from the driving sprocket.

(o) Couple and tighten the track.

After the first 500 km of run remove the tracks, and, if necessary, remove one shoe from each track. Mount the tracks on the pin ends so that each track is turned relative to the matching shoe by an angle determined by a templet. Tighten up the wedge nuts by a wrench, applying an effort of 35 kgf to a 400-mm long arm (one man can apply this effort by one hand). This done, reinstall the tracks on the vehicle.

8.4.5. Tightening Up the Driving Sprocket Plugs

Tighten up the driving sprocket plugs every 2400-2500 km of run as follows.

(a) Unscrew the securing bolts of the side mud guard, raise it and secure in the upper position.

(b) Unlock and unscrew two locking bolts 55 (Fig. 218) of driving sprocket plug 30.

(c) Tighten up driving sprocket plug 30.

(d) Turn in two locking bolts of the plug, lock them with tab washers and fix the filler plug with the help of one of bolts 55.

(e) Release the side mud guard and secure it with bolts.

8.4.6. Checking the Track Adjusting Mechanism and Replenishing It with Lubricant

Check and replenish the track adjusting mechanism every 2400-2500 km of run as follows.

(a) Open the rear doors.

(b) Unscrew the plug designed for checking the lubricant level in the track adjusting mechanism.

(c) Check the lubricant level in the track adjusting mechanism (the lubricant level must be against the lower edge of the filler hole). If the amount of lubricant is not sufficient, add grease ЦИАТИМ-208 by means of a grease gun.

(d) Screw in the plug.

(e) Close the rear doors.

8.4.7. Lubricating the Running Gear

Lubricate the running gear every 2400-2500 km of run as follows.

(a) Unscrew filler plugs 19 of the road wheels, support rollers and driving sprockets.

(b) Fill the idler wheels and road wheels with oil MT-16п by means of a grease gun up to the level holes.

(c) Screw in the filler plugs of the road wheels, support rollers and idler wheels.

(d) Unscrew plug 13 for lubrication of the road wheel arm axle bushings.

(e) Screw the grease gun adapter in the lubricating hole.

(f) Add 100-160 g of grease УС to each road wheel arm.

(g) Unscrew the adapter and screw in the plug.

(h) Applying the same procedure, lubricate the other supports of the road wheel arms.

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8.4.8. Replenishing the Hydraulic Shock Absorber with Working Fluid

Replenish the hydraulic shock absorber with the working fluid every 2400-2500 km of run as follows.

(a) Place the vehicle on a level ground.

(b) Remove dirt from around plug 22 and unscrew the latter from shock absorber 15.

(c) Check to see that the oil level is at the lower edge of the filler hole. If the oil level is not seen, replenish the shock absorber with a mixture consisting of transformer oil (50%) and turbine oil (50%).

(d) Screw in the plug.

8.4.9. Using the Sixth Road Wheel Instead of Idler Wheel when the Latter Fails

If the idler wheel or its crank is damaged, provide further movement as follows.

(a) Relieve the road wheel by means of a jack or by placing the wheel over a ditch.

(b) Uncouple the track and remove nine shoes from it.

(c) Unlock the idler wheel crank and remove the idler wheel together with the crank.

(d) Dismount the hydraulic shock absorber.

(e) Remove the torsion bar by means of the puller.

(f) Raise the sixth road wheel until the road wheel arm thrusts against spring stop 4. Install the torsion bar and secure it.

8.5. TROUBLES AND REMEDIES

Trouble	Cause	Remedy
During movement vehicle pulls aside	Tracks adjusted unevenly	Adjust track tension
Hubs of road wheels and idler wheels overheat	No grease inside hubs Bearings damaged	Add grease Check and, if necessary, replace bearings
Road wheel arm strikes against stop frequently and sharply	Torsion bar worn out Hydraulic shock absorber faulty	Replace torsion bar Check and, if necessary, replace shock absorber
Idler wheel or its crank is damaged		If necessary, use sixth road wheel as idler wheel (See Para. 8.4.9). In this case, drive vehicle only in low gears at a speed not exceeding 10 km/h. Turn the vehicle smoothly. At first opportunity install serviceable crank or idler wheel
Vehicle fails to develop maximum speed on water	Guide vanes damaged	Replace guide vanes
Fluid leakage from under shock absorber rod	Packing damaged	In absence of dripping, hydraulic shock absorber is considered fit for further use. In case of excessive leakage, replace shock absorber

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Trouble	Cause	Remedy
Traces of lubricant coming from packings of running gear units	Plugs loosened, gaskets or sealing rings damaged	Tighten up plugs or replace gaskets. In absence of dripping, running gear units are considered fit for further use. In case of excessive leakage, examine packings. If they cannot be replaced in situ, remove the given unit and send it for repair
Separation of rubber tyre from road wheel rim		If the length of separated tyre is not in excess of 120 mm, depth is not more than 40 mm and the number of separation points is not more than four and distance between them is not less than 200 mm, road wheel is considered fit for further use. Otherwise, replace road wheel
Road wheel tyre rubber torn out	Tyre mechanically damaged by track shoe lugs during sharp turns at high speed, or by foreign objects	If dimensions of damaged spots do not exceed 80x80 mm and number of them is not more than 4 (or 60x60 mm and number, not more than 8) and distance between damaged spots is not less than 200 mm, road wheel is considered fit for further use. Otherwise, replace road wheel

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9. ELECTRICAL EQUIPMENT

9.1. GENERAL

The electrical equipment of the vehicle comprises the power supply sources, current consumers, auxiliary equipment, measuring instruments and electric wiring.

All the electrical equipment of the vehicle is subdivided into the following systems:

- power supply system (power supply sources);
- electrical equipment of the laying drives;
- electrical equipment of the loading mechanism;
- electrical equipment of the vision devices and sights;
- guidance system 9C428;
- electrical equipment of the ABC protection system;
- electrical equipment of engine protection system;
- lighting and light signalling systems;
- measuring instruments.

The diagram of the general electrical equipment is shown in Fig.226.

9.2. POWER SUPPLY SOURCES

The power supply sources of the vehicle are two starter storage batteries and a D.C. generator.

9.2.1. Starter Storage Batteries

There are two acid storage batteries, type 6-CT3H-140M, on the vehicle. They are installed in a special compartment at the rear of the troop compartment behind the fuel tank (Fig.227) and connected in series. The total voltage of the batteries is 24 V, and capacity is 140 A.h.

Each storage battery consists of six cells arranged in a common case and connected in series with the use of cell connectors 9 (Fig.228). Each cell includes group of positive plates 17 and group of negative plates 14 placed in an ebonite container which is filled electrolyte. Separators 16 laid between the plates prevent any contact between the latter. T main component of each plate is a lead grid whose meshes are filled with active material fabricated from lead oxides and treated by the electrochemical method. As a result of treatment, the positive plates are coated with lead peroxide, and the negative plates, with porous metallic lead.

Aqueous solution of sulphuric acid is used as the electrolyte. The cell containers are closed with covers 10 having three holes. The central (filler) hole is closed with plug 8 having a vent. The other two holes serve to pass terminal posts 12 of the plate groups. The walls-to-cover joint is sealed with a gasket. Besides, the cover is sealed over its edges with acid-resistant paste.

Protective shield 13 provided in each cell protects the plates and separators from mechanical damage. At the bottom, the plate groups rest on four lugs 15 made on the cell bo

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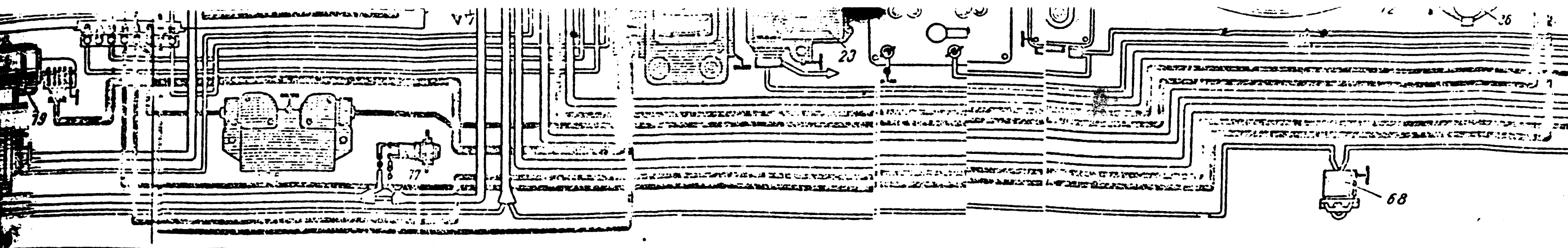

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FIG.226. DIAGRAM OF ELECTRICAL EQUIPMENT

1 - central panel; 2 - headlight of vision device TBH; 3 - right-hand front marker light; 4 - electric motor of front water drainage pump; 5 - electric motor of oil priming pump; 6 - limit switch of stop light; 7 - pressure warning unit; 8 - generator; 9 - starter; 10 - sending unit of gearbox pressure gauge; 11 - sending unit of engine oil pressure gauge; 12 - flap lamp; 13, 14 - flap lamps; 15 - dome lamp; 16 - socket; 17 - parking brake signal light panel; 18 - vision device TBHO-2; 19 - high-voltage cable; 20 - power pack of vision device TBHO-2; 21 - limit switch of parking brake; 22 - gyro direction indicator ГПК-59; 23 - driver's vision devices heating control panel;24 - electropneumatic valve of engine air starting system; 25 - electropneumatic valve of engine air-and-liquid cleaning system; 26 - electropneumatic valve of stopping brake pneumatic control; 27 - button to start vision device air-and-liquid cleaning system; 28 - driver's hatch limit switch; 29 - spotlight ОУ-Г2; 30 - electric filter; 31 - headlight; 32 - turret board; 33 - turret collector ring box; 34 - turret dome lamps;35,36 - turret sockets; 37 - sending units of coolant and oil temperature gauges; 38 - tachometer generator; 39 - preheater glow plug; 40 - preheater injector heater; 41 - electric motor of preheater pump unit; 42 - dome lamp; 43 - electric motor of rear water drainage pump and smoke-generating equipment pump; 44 - dome lamp, 45 -electrogmagnet of valve of smoke-generating equipment, 46 - electric motor of fuel feed pump БЦН; 47 - electric filter; 48 - differential-minimum relay; 49 - storage batteries; 50 - voltage regulator; 51 - stabilizing transformer; 52 - electric motor of troop compartment heater; 53 - - starter contactor; 54 - battery contactor; 55 - socket for external power source; 56 - power board; 57 - ammeter shunt; 58 - vision device heating box for right-hand section of troop compartment; 59 - tail right-hand marker light; 60 - limit switch of right rear door; 61 - stop light; 62 - limit switch of left rear door; 63 - - tail left-hand marker light; 64 - vision device heating box for left-hand section of troop compartment; 65 - troop compartment dome lamp; 66 - heater motor switch; 67 - dome lamp; 68 - socket; 69 - glass heating air regulator; 70 - turret collector ring box of commander's hatch; 71 - button of spotlight ОУ-Г2; 72 - protective glass heater switch panel; 73 - commander's vision device TKH-3Б; 74 - limit switch of commander's hatch cover; 75 - supply unit of radio station; 76 - control box No.1 of interphone system; 77 - horn button; 78 - electric filter; 79 - converter ПАГ-1Ф; 80 - sending unit of electric speedometer; 81 - horn; 82 - headlight with blackout devce; 83 - left-hand marker light

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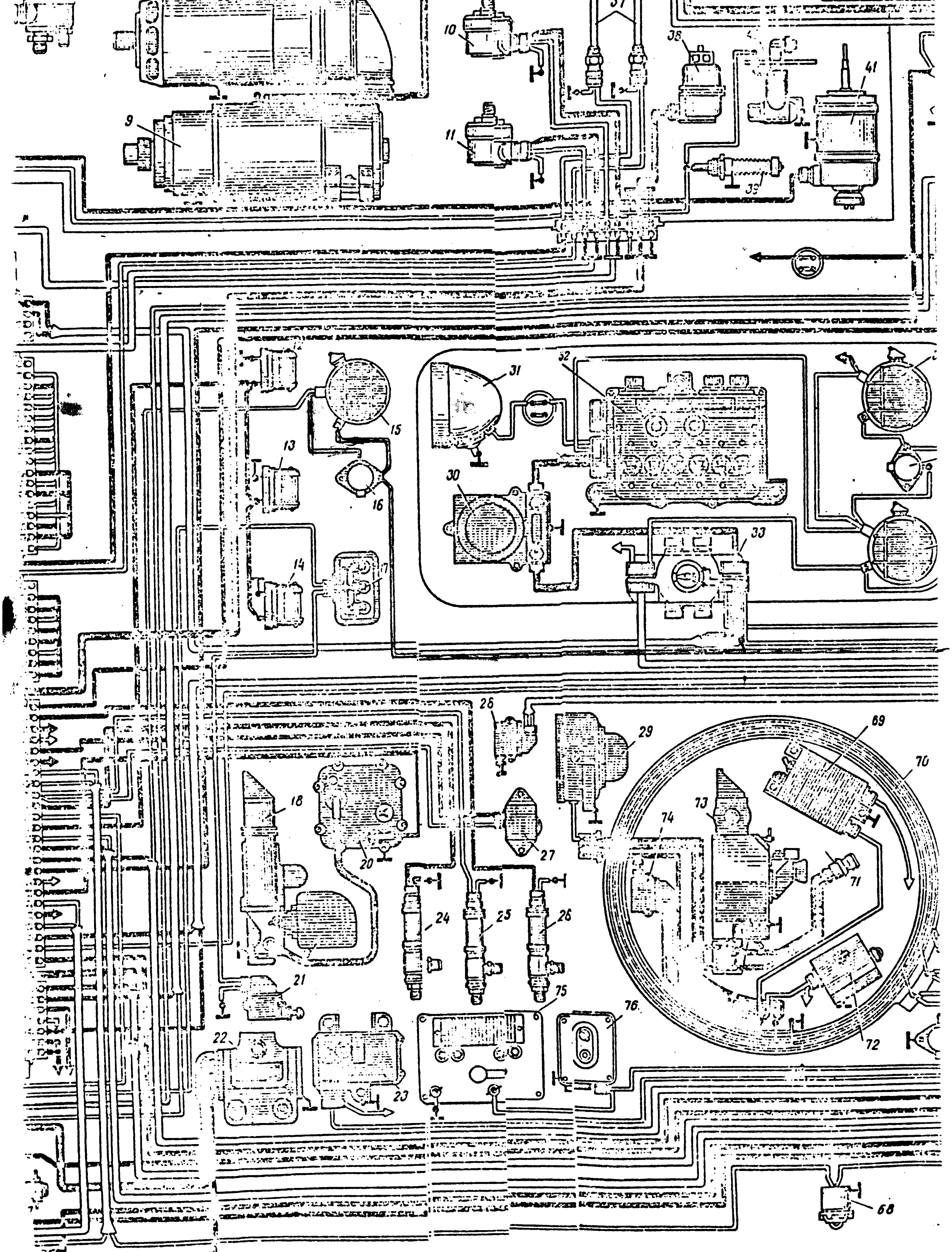

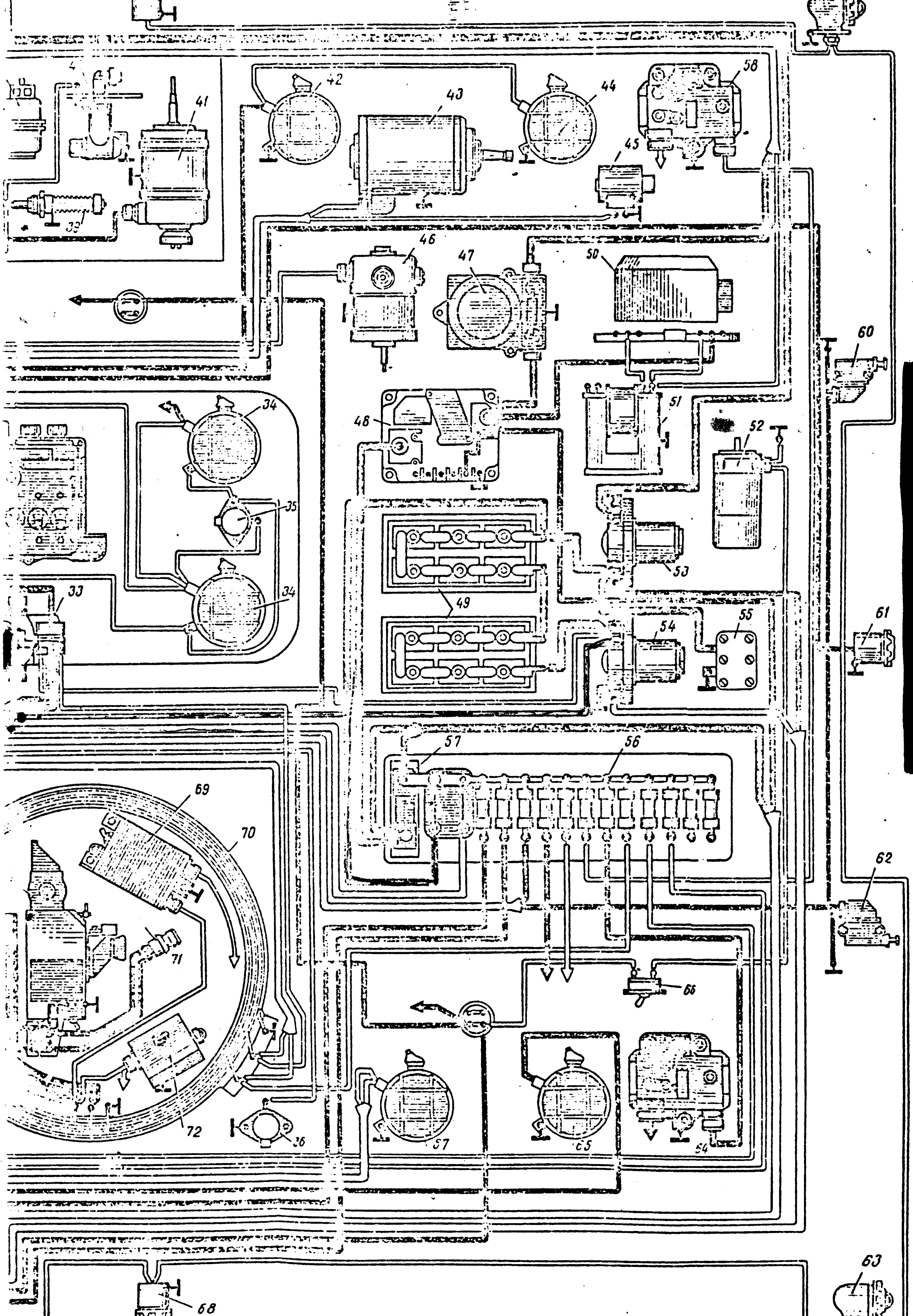
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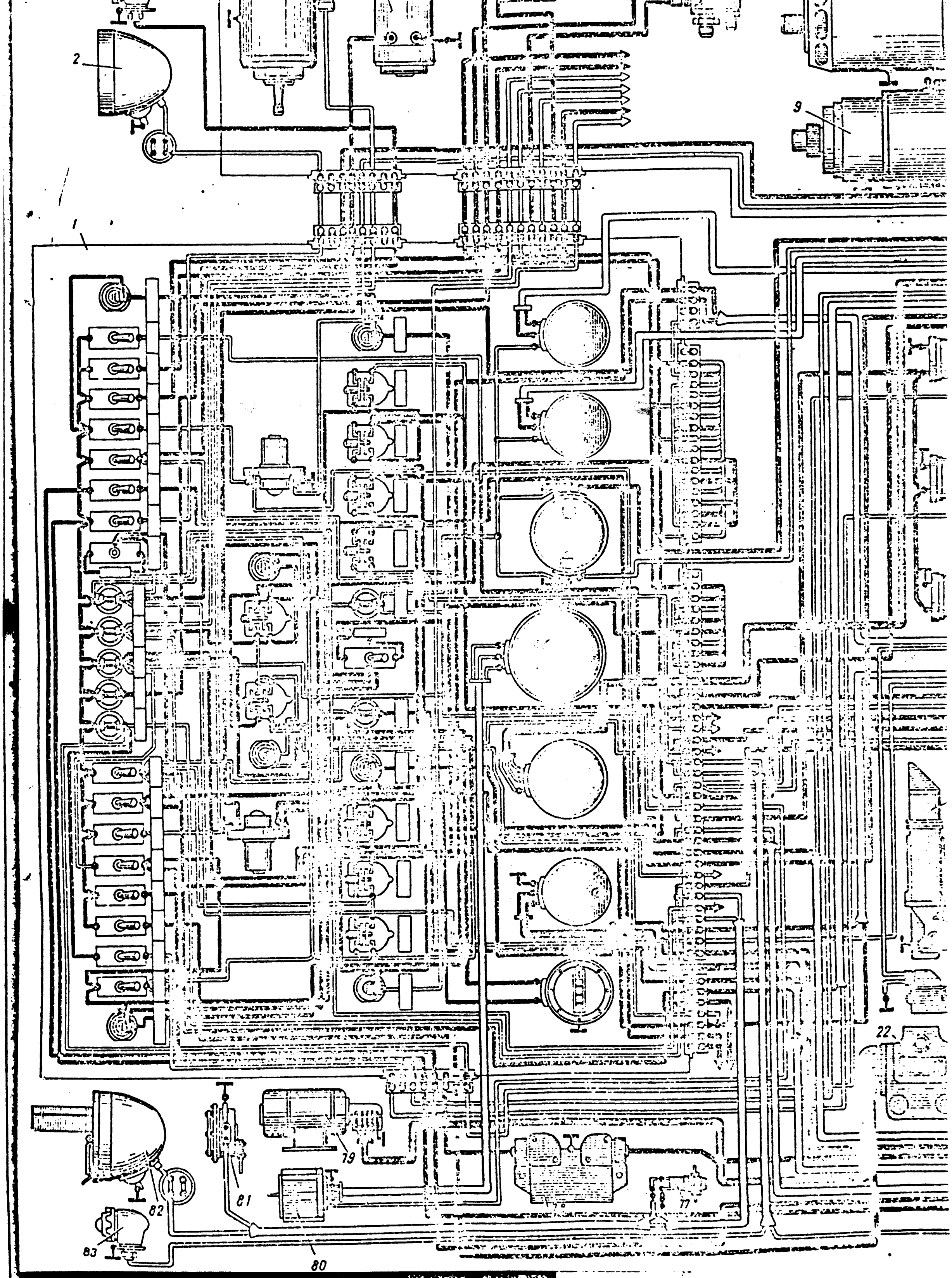

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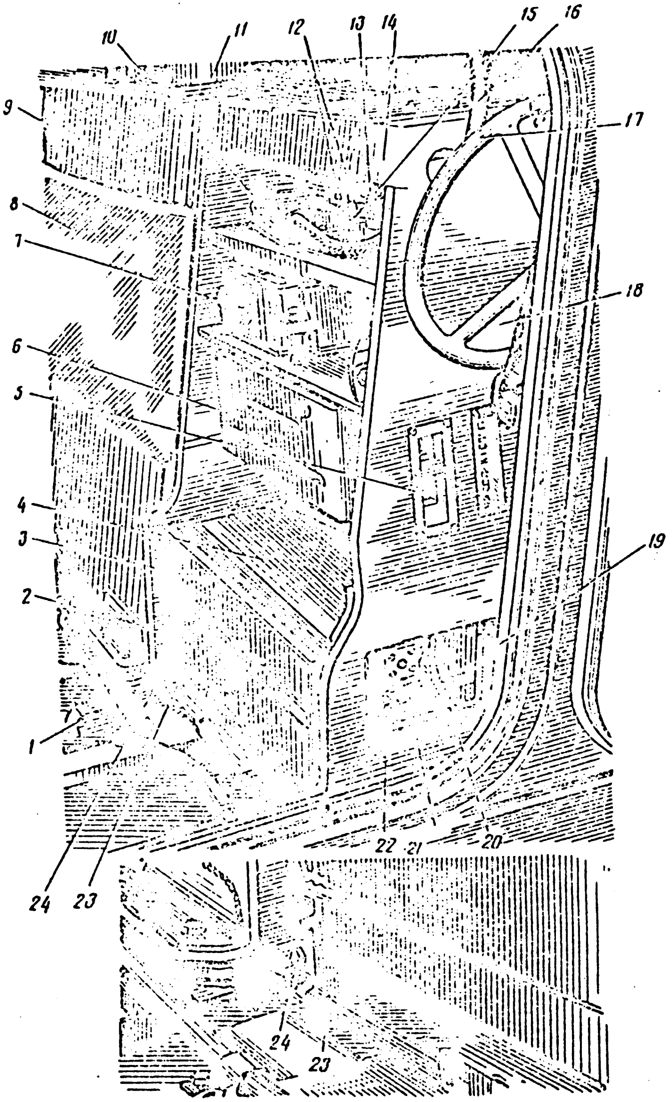

FIG.227. STORAGE BATTERY COMPARTMENT

1 - rack base; 2 - battery basket; 3 - left-hand storage battery; 4 - battery lid; 5 - slave starting socket; 6 - power board; 7 - voltage regulator; 8 - back of left-hand troopers' seat; 9 - fuel tank; 10 - radio interference filter Ф-5; 11 - filler neck of fuel tank; 12 - cover locks; 13 - troop compartment heater; 14 - battery compartment; 15 - limit switch; 16 - heater radiator pipe; 17 - handwheel of rear door locking mechanism; 18 - heater motor switch; 19 - right-hand storage battery; 20 - jumper; 21 - basket coupling bolt; 22 - handle; 23 - fastening strap; 24 - bolt

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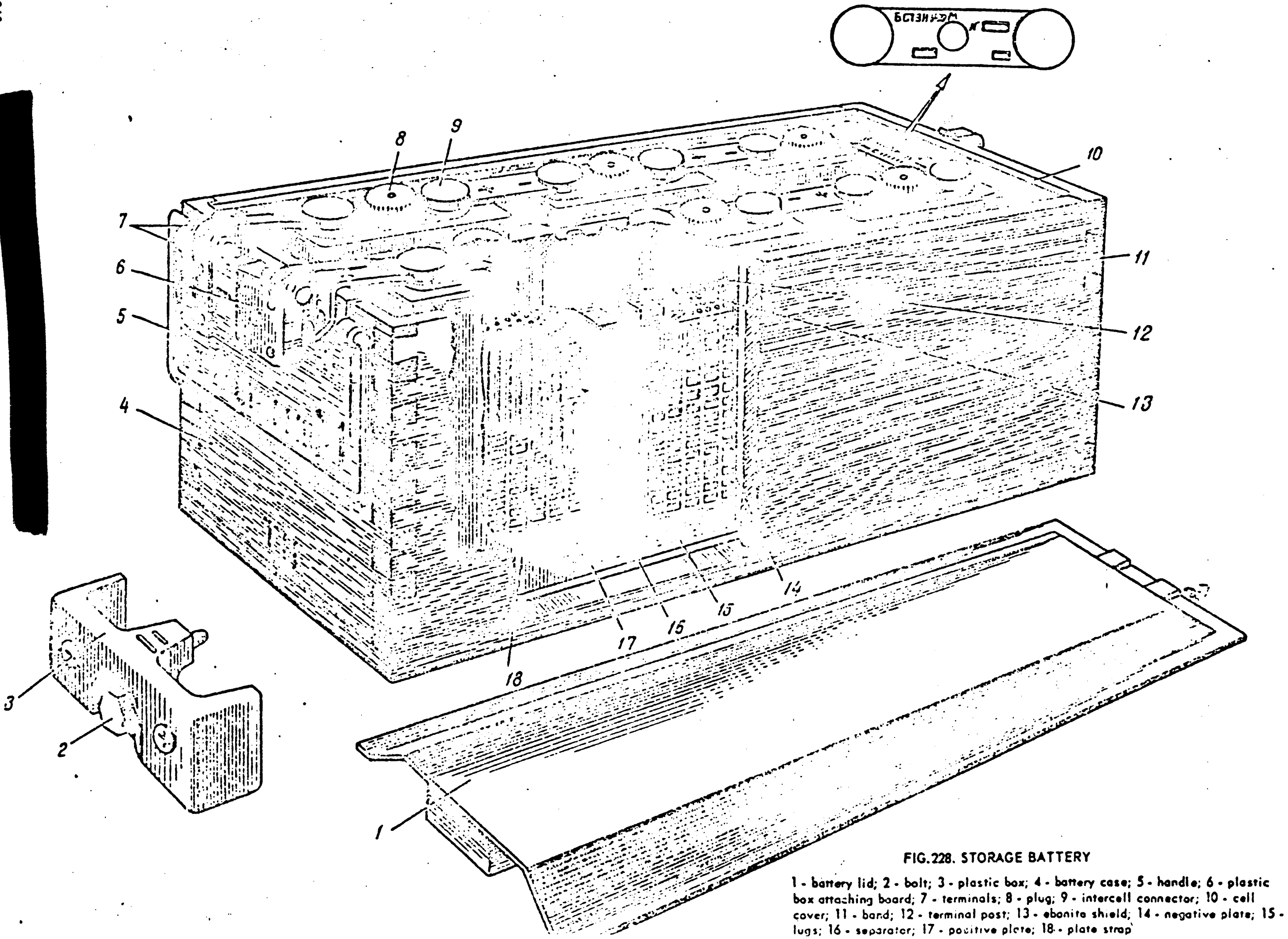

FIG.228. STORAGE BATTERY

1 - battery lid; 2 - bolt; 3 - plastic box; 4 - battery case; 5 - handle; 6 - plastic box attaching board; 7 - terminals; 8 - plug; 9 - intercell connector; 10 - cell cover; 11 - band; 12 - terminal post; 13 - ebonite shield; 14 - negative plate; 15 - lugs; 16 - separator; 17 - positive plate; 18 - plate strap

[redacted]

ten. The battery terminals are connected with extreme cell terminal posts 12 and with the wire lugs by means of bolts and nuts. On top, the battery case is coated with acid-resistant varnish. The terminals are protected with plastic box 3. The storage battery is reinforced with two bands 11 passing between the cell containers. The battery has carrying handle 5.

The battery functions as follows. The electric energy accumulated in the cell in the course of charging is supplied to the external circuit.

As the battery is discharged the lead dioxide on the positive plates and the porous lead on the negative plates are transformed into lead sulfate. The lead sulfate is formed due to the electrochemical interaction of the active material of the plates and sulphuric acid; and as a result, the electrolyte specific gravity decreases.

The amount of electric energy that can be accumulated in the cell and supplied to the external circuit depends on the amount of the active material participating in the electrochemical reaction.

As the battery is charged, the electric current flowing through the plates and electrolyte transforms the lead sulfate into lead dioxide on the positive plates and into porous lead on the negative plates. Part of the charging current is consumed for decomposition of the water into hydrogen and oxygen, and the electrolyte specific gravity increases. The battery is considered charged, when the specific gravity of the electrolyte stops rising, the voltage is stabilized and heavy gas evolution is observed.

Care of the storage batteries boils down to regular checks of the battery condition and charge state, checking the electrolyte level and replenishing the batteries with distilled water, cleaning and lubricating the terminal posts, terminals and cell connectors, cleaning and checking the sealing compound, and also boost-charging the batteries.

The battery charge state may be approximately determined by the voltammeter readings.

Checking the battery charge state by the voltage:

(a) close the battery switch;

(b) set the gear shift lever into neutral;

(c) apply the stopping brake;

(d) set the manual fuel feed control lever at zero feed;

(e) press the starter button for 5-7 s without feeding the fuel to the engine and watch the voltammeter.

The voltage should not be less than 17 V. Otherwise, the batteries are subject to boost charging.

Checking the battery charge state by the current:

(a) prepare the engine for start;

(b) switch off all the consumers;

(c) set the gear shift lever into neutral and tighten up the stopping brake;

(d) start the engine and run it for 10 - 15 min. If the charging current exceeds 50 A, the storage batteries are subject to boost-charging.

Checking the electrolyte level

When the vehicle is used at elevated temperatures, regularly check the electrolyte level. For this purpose, unscrew plug 8 and insert a glass tube in the filler neck. The electrolyte level must be 10 - 12 mm above the plates. If the level is lower than required, add distilled water.

Checking the cases, terminals and sealing compound

Examine the cases, terminals and sealing compound externally during maintenance inspections. Coat the terminals with a thin layer of grease УН (УС). Restore the damaged sealing compound.

Checking the battery charge state by the electrolyte specific gravity

Perform this check when the batteries do not function normally. Do it on checking the charging current and voltage. At least every three months boost-charge the batteries by a 8-A current. For checking the cells, remove them from the storage battery.

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Removing the cells

(a) Open the battery switch.

(b) Remove the left-hand (as viewed in the direction of forward motion) seat of the troop compartment.

(c) Undo the latches, take off the left-hand cover of the battery compartment.

(d) Undo the latches and take off the two covers of the rear access holes of the battery compartment in order to give an access to the battery protective boxes.

(e) Remove the terminal protective boxes from the right-hand and left-hand storage batteries, for which purpose unscrew the securing bolts through the access holes.

(f) Disconnect the wires and jumper from the storage batteries. Put the protective boxes on the storage batteries.

(g) Unscrew two bolts 24 (Fig.227) of the L.H. battery basket and remove fastoning straps 23.

(h) Remove the L.H. and then R.H. storage batteries together with the baskets from the compartment. Loosen basket coupling bolts, and take the storage batteries out of the baskets. While removing the batteries, do not incline the cells by great angles and see that the terminals are not shorted.

Checking procedure of the electrolyte specific gravity

The electrolyte specific gravity in a fully charged cell must be:

- 1.27 for central regions with temperatures up to -30°C;
- 1.29 for northern regions with temperatures up to -40°C;
- 1.25 for southern regions with temperatures up to -20°C;
- 1.31 in winter and 1.27 in summer for regions with a sharply continental climate (below -40°C).

Check the electrolyte specific gravity with the help of an areometer. Introduce the temperature correction in the measured specific gravity. If the electrolyte temperature is above +15°C, add 0.01 per each 15° to the areometer reading, and if the electrolyte temperature is below +15°C, subtract the same value.

For determining the battery charge state by the electrolyte specific gravity calculate the difference between the actual and rated values of the specific gravity. As the specific gravity is decreased by 0.01, the battery is discharged by 5 - 6.25%. If the initial specific gravity is 1.27, and the actual value is 1.22, the battery is discharged by 25 - 30%.

In service the storage batteries may be discharged by:

no more than 50% in summer,

no more than 25% in winter.

If the storage batteries are excessively discharged, they must be boost-charged.

Installing the storage batteries on the vehicle

(a) Remove the terminal protective box and connect the jumper to terminal "+" of the R.H. battery before installation of the latter on the vehicle. After that, close the protective box.

(b) Open the battery switch.

(c) Remove the left-hand (as viewed in the direction of forward motion) seat of the troop compartment.

(d) Open the latches and take off the left-hand cover of the battery compartment.

(e) Open the latches and remove two covers of the rear holes in order to provide an access to the protective boxes of the storage batteries.

(f) Mount the R.H. storage battery in the basket and tighten up the latter with the coupling bolt.

(g) Install the R.H. battery with the basket in the compartment and push it till the basket lugs enter the slots of the compartment bottom flange.

(h) Mount the L.H. battery in the basket and tighten up the coupling bolt.

(i) Install the battery with the basket in the compartment so that the left-hand basket lugs enter the recesses of the right-hand one.

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(k) Connect the jumper and the wires to the battery terminals through the rear acces holes.

(l) Reinstall the terminal boxes, access hole covers and the seat.

9.2.2. Generator BГ-7500

The generator serves to supply the consumers with electric power and to recharge the storage batteries. The generator operates in conjunction with the voltage regulator, differential minimum relay and stabilizing transformer.

The generator is mounted on the engine and driven through the gears of the transmis mechanism and clutch (Fig.147) having rubber keys.

The BГ-7500 generator (Fig.229) is a D.C. six-pole, compound-excitation machine whi is cooled by a fan.

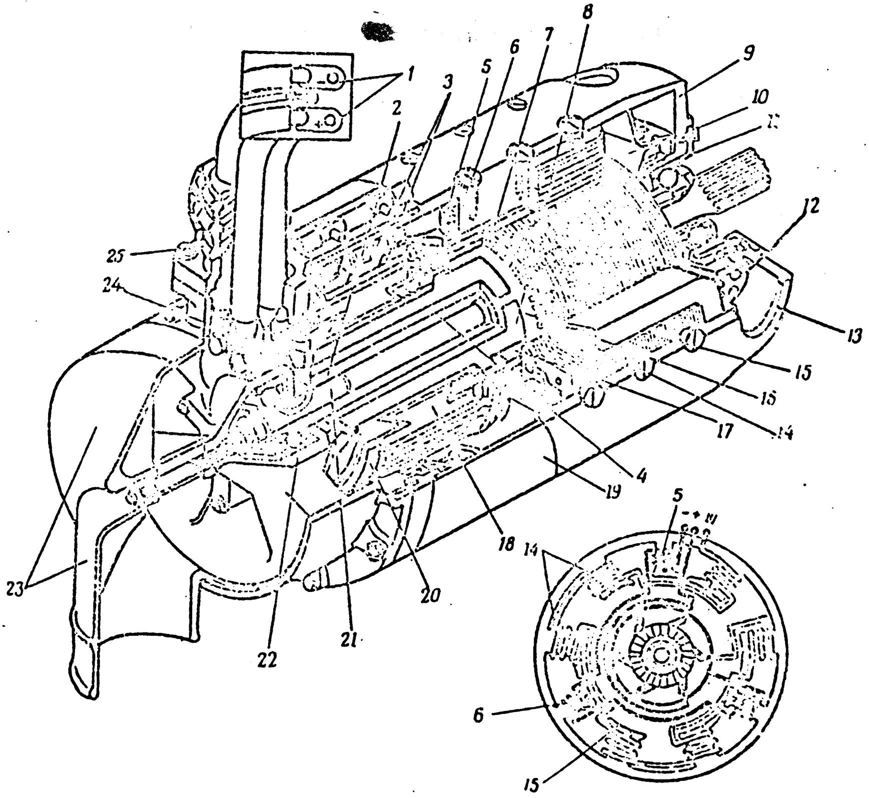

FIG.229. GENERATOR

1 - terminals; 2 - armature shaft; 3 - brushes; 4 - pressure washer; 5 - commutating winding; 6 - commutating pole; 7 - armature winding; 8 - ducts for cooling the air; 9 - generator frame; 10 - fan; 11 - flange; 12 - fan housing; 13 - cooling air outlet port; 14 - shunt winding, 15 - main pole; 16 - armature; 17 - commutator nut; 18 - commutator; 19 - protective band; 20 - commutator bars; 21 - resilient shaft; 22 - bearing end shield; 23 - cover with air supply branch pipe; 24 - panel; 25 - nipple

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The generator consists of frame 9, six main poles 15 and three commutating poles 6 with windings, armature 16 with commutator 18, brush holders with brushes 3, cover 23 with an air supply branch pipe and protective band 19.

The cylindrical frame of the generator has a bottom plate. Attached to the inside of the frame are six main and three commutating poles which are made from sheet electrical steel. The main poles hold coils with shunt field windings. Winding 5 of the commutating poles is intended to provide for the desired electric characteristics of the generator and to reduce the sparking under the brushes. The coils are series-connected. One end of the winding is connected to the positive brushes of the generator, and the other end, to terminal "Я" on the generator frame.

The generator armature includes hollow shaft 2 which carries a cross-piece with a commutator and an armature stack; the latter is composed of electrical-steel sheets and insulated on the end face with fibre-glass laminate sheets. Commutator 18 consists of 114 copper-cadmium bars insulated from each other with mica. The ends of the winding tucked in the slots of the armature are soldered to the commutator bars. Fitted on the shaft between the armature stack and the frame wall is fan 10. Placed inside the armature shaft is resilient shaft 21 one end of which is connected through a shank and key with the armature shaft, and the other end is engaged with the splines of shaft 16 (Fig.147) of the generator drive clutch.

Six brush holders secured on the frame ribs between ports 13 mount three brushes 3 each (Fig.229). The brushes are pressed to the commutator with the help of spring-loaded levers.

Bolted to the generator frame on the commutator side is end shield 22 made from aluminum alloy. Terminal panel 24 attached to the end shield has bronze bushing to which cable shoes of terminals 1 are secured. The drive clutch is bolted to the end face of the generator frame.

The generator is cooled as follows: fan 7 (Fig.230) mounted on the shank of hollow cylindrical housing 19 (Fig.147) sucks air from the air cleaner and delivers it to the

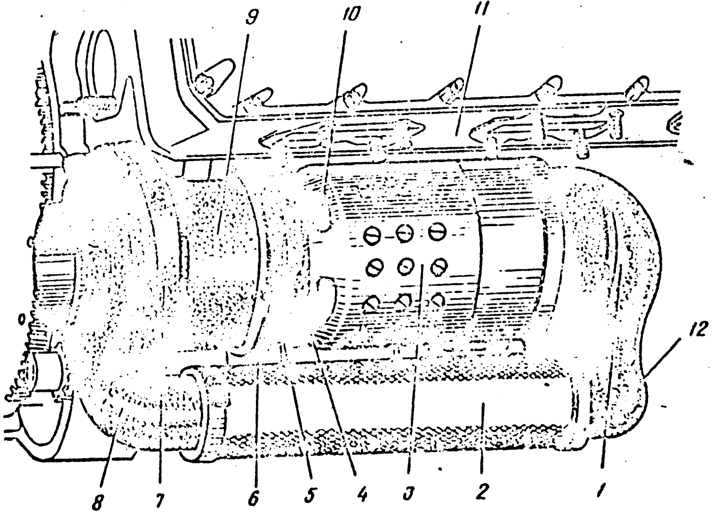

FIG.230. GENERATOR COOLING DIAGRAM

1 - cover with branch pipe; 2 - hose; 3 - generator; 4 - spacer; 5 - bolt; 6 - yoke; 7 - fan; 8 - branch pipe; 9 - generator drive coupling; 10 - cooling air outlet port; 11 - cylinder block-and-crankcase unit; 12 - branch pipe

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space of cover 1 through branch pipe 8 and hose 2. From here the air flows in three directions: one part of air is supplied for cooling the commutator and brushes and is discharg outside through the hole in the middle portion of the frame; the second part of air passe along the generator, cools the pole coils and armature stack and escapes into the atmosph through holes in protective housing 12 (Fig.229) and port 13 in the frame; the third part of air passes through the channels of the revolving armature, and exhaust fan 10 secured the armature shaft discharges it outside through the holes in the protective housing and frame port.

The principle of generator operation is based on generation of an electromotive forc in the conductors when the latter cross the magnetic lines. As the armature together with its windings revolves in the electromagnetic field (produced by the six main and three commutating poles), crosses the magnetic lines, an electromotive force is induced in the armature windings. The voltage produced in the winding is applied to the commutator bars from which it is taken off by the brushes.

9.2.3. Differential Minimum Relay ДМР-400Т

The relay serves to disconnect the generator from the vehicle mains when its voltage is less than that of the storage batteries, and to connect the generator when its voltage exceeds that of the storage batteries.

Relay ДМР-400Т is mounted in the battery compartment.

The peculiar feature of the relay is that it connects the generator to the batteries only if the generator voltage exceeds the battery voltage by 0.3 - 0.7 V irrespective of the absolute value of the generator voltage (unlike the reverse-current relay). The generat is disconnected when the reverse current reaches 15 - 35 A.

The basic components of the relay are: contactor K (Fig.231), cut-in relay P3, auxilia relay P4, control differential relay P5, additional voltage relay P2, auxiliary switching relay P1 and resistor R.

All the components are secured on common panel 6 (Fig.232).

The relay panel is manufactured of press material; it has pressed-in bushings for securing the relay components. The panel serves also as the cover of body 7. All the relay components are interconnected with heat-resistant wire having a fluoroplastic insulation and fibre-glass braiding.

Contactor K (Fig.231) is an actuating element of the circuit; it serves to connect generator Г to and disconnect it from the vehicle mains.

The contactor (Fig.233) has one pair of normally-open contacts 11 breaking the circuit in two points. The contactor represents a pull-in electromagnet whose core 8 carries movable contact bus-bar 5 closing stationary contacts 10. The ends of the generator and battery circuits are brought to power terminals 4 which are connected to the stationary contact Contact bus-bar 5 is freely fitted on the rod of core 8 and pressed to its collar by buffer spring 6. Return spring 3 keeps the contacts constantly open. From above, the contactor is closed with cover 3 (Fig.232) which is attached to panel 6 with four screws.

Control relay P5 (Fig.231) serves to apply the voltage to the contactor winding when the generator voltage exceeds the battery voltage and to disconnect the generator when the reverse current starts flowing from the storage batteries to the generator.

It represents an electromagnetic relay polarized by means of permanent magnets.

The control relay consists of two steel plates 1 and 11 (Fig.234) connected by three permanent magnets 20. The plates hold two poles 2 between which armature 4 is suspended by means of a plate spring; the latter is secured on the middle portion. Owing to such an attachment, the armature is free to turn by a small angle between pole shoes; the armature cannot touch the pole shoes since its travel is limited by screws 19. One of the screws 5 is a contact one; it is insulated. Secured on the relay armature against contact screw 5

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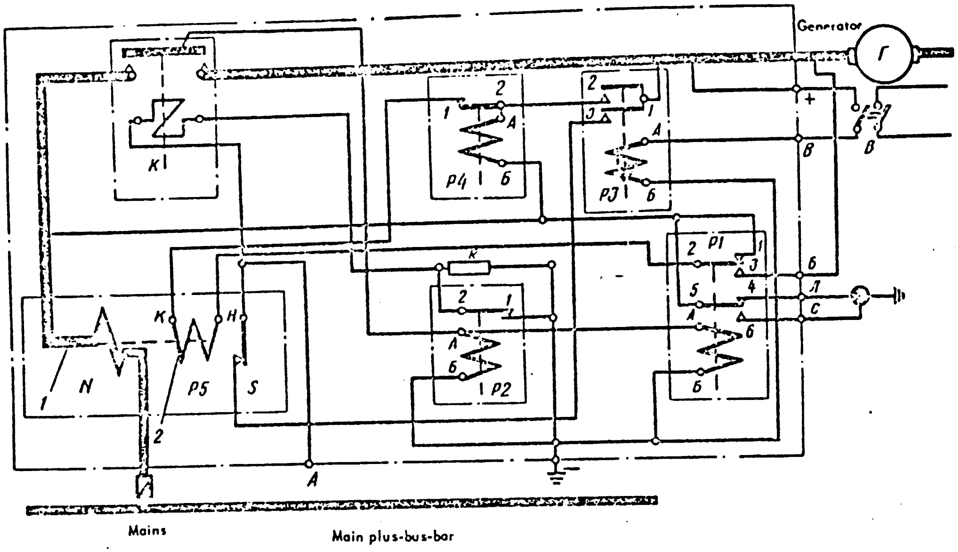
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Main plus-bus-bar

FIG.231. SCHEMATIC DIAGRAM OF DIFFERENTIAL MINIMUM RELAY

K - power contactor; P4 - auxiliary relay (TKE210ДТ); P3 - cut-in relay (TKE1P2ДТ); P5 - control differential relay (ДР); P2 - additional voltage relay (TKE210ДТ); P1 - auxiliary switching relay (TKE22ПДТ); B - switch; Г - generator; R - resistor; 1 - turn of series winding; 2 - differential winding of control relay

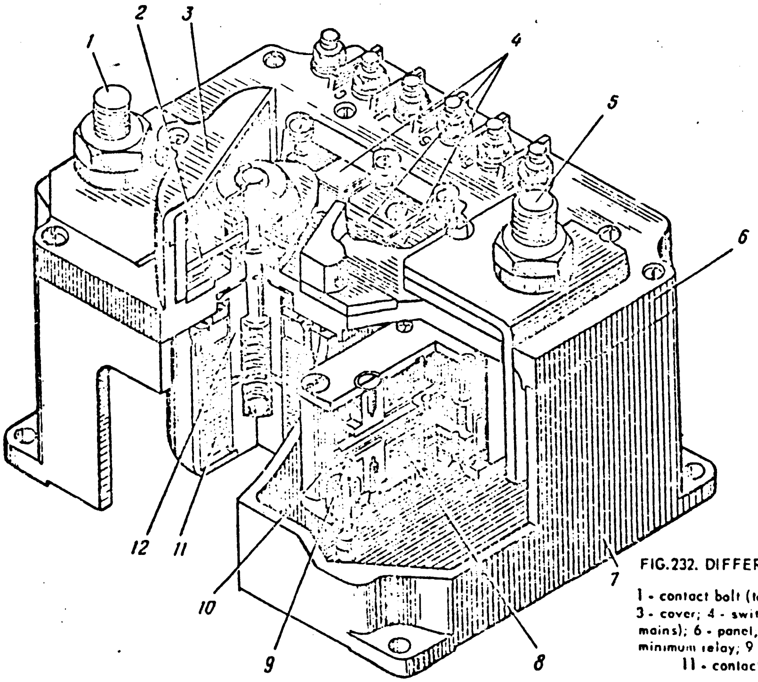
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FIG.232. DIFFERENTIAL MINIMUM RELAY ДМР-400T

1 - contact bolt (to connect generator); 2 - movable contact; 3 - cover; 4 - switching relay; 5 - contact bolt (to connect mains); 6 - panel, 7 - relay body; 8 - winding of differential minimum relay; 9 - stationary contact, 10 - relay armature; 11 - contactor winding; 12 - contactor pole

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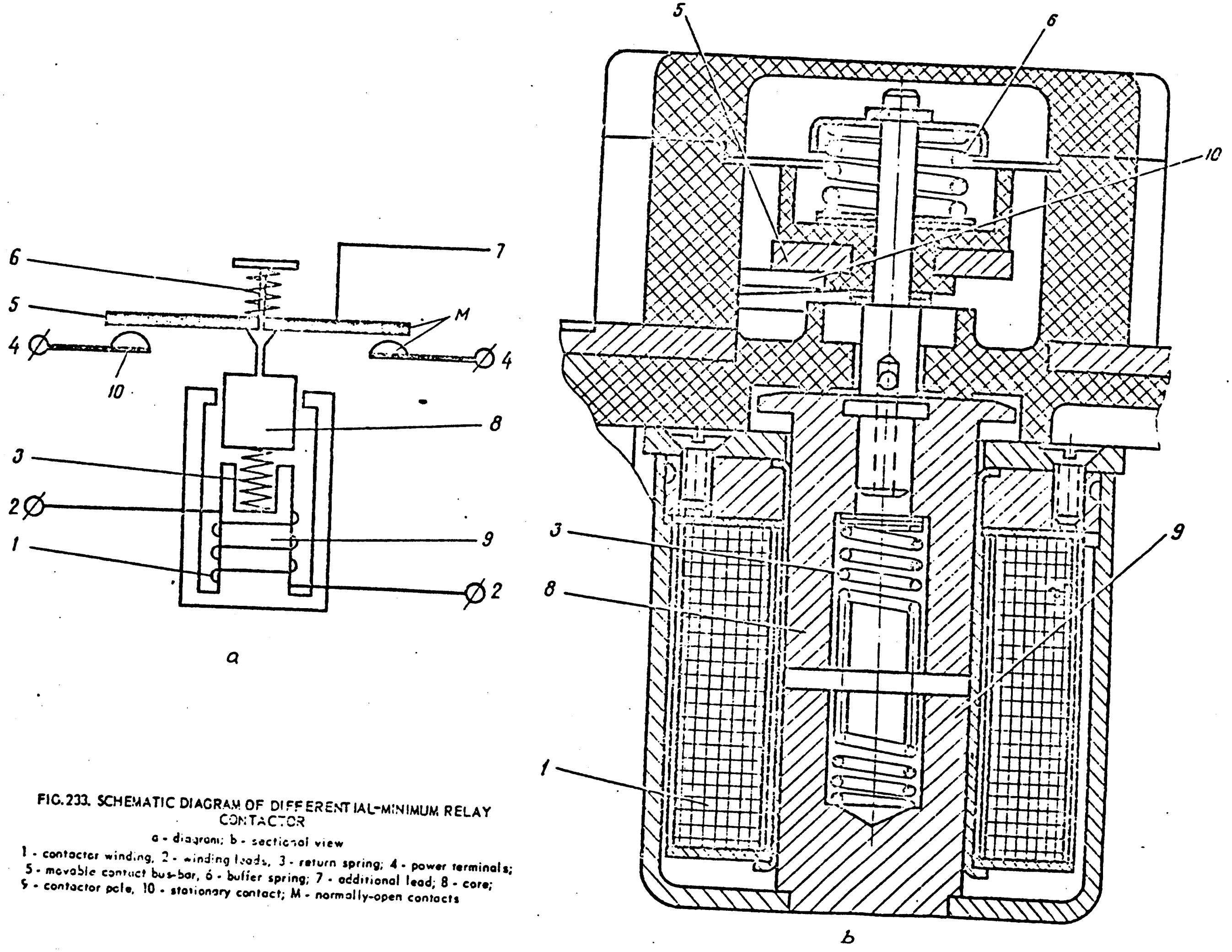

FIG. 233. SCHEMATIC DIAGRAM OF DIFFERENTIAL-MINIMUM RELAY CONTACTOR

a - diagram; b - sectional view

1 - contactor winding, 2 - winding leads, 3 - return spring; 4 - power terminals; 5 - movable contact bus-bar, 6 - buffer spring; 7 - additional lead; 8 - core; 9 - contactor pole, 10 - stationary contact; M - normally-open contacts

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is a movable contact. The armature freely moves between the thrust and contact screws inside differential winding 2 (Fig.231) and turn 1 of the series winding which are rigidly secured in the relay frame between the plates.

Operation of control relay. When the generator voltage exceeds the battery voltage, a current starts flowing in relay winding 2; the voltage of this current is such that the left portion of armature 4 (Fig. 234) is positive, and the right portion is negative.

Interacting with upper and lower poles 2, the armature takes up a position at which its contact and contact screw 5 are closed, and as a result, the mains voltage is applied to the contactor winding.

As the current flows through the series turn, the magnetic field of the armature is intensified, and armature 4 is held in the indicated position more reliably. When a reverse current starts flowing from the storage batteries via the series turn and when the intensity of this current reaches 15 - 50 A, the polarity of the armature is reversed and the contacts get open; as a result, the contactor is deenergized, and consequently, the generator is disconnected from the battery circuit.

Small-size cut-in relay P3 (Fig.231) is of a switching type; it is designed to feed the voltage from the generator to the contacts and windings of the auxiliary relay and to the shunt winding and contacts of the control relay. Relay P3 eliminates spurious electric circuits in the idle relays.

The relay in question (Fig.235) has two pairs of normally-open contacts: movable contacts 6 secured on the end of armature 9, and stationary contacts 20 press-fitted into insulating plastic panel 1 and connected with output bus-bars 3.

The relay is of a valve type with a Ш-shaped magnetic circuit (core 16); it consists of panel 1, core 16, armature 9 with contacts, return spring 14 and cap 18.

Armature 9 has the shape of a rocker; it is free to turn through a certain angle in frame 7 under the action of electromagnetic field of the electromagnet or under the action of return spring 14. When the electromagnet is deenergized, armature 9 occupies a position in which contacts 6 are open. As winding 15 is energized, armature 9 turns and closes the contacts, thus making the relay control circuits.

Auxiliary relay P4 (Fig.231) serves to prevent overheating of the shunt winding of the differential relay when the difference between the generator and battery voltages exceeds 14 V. It also prevents wrong polarity of generator connection to the mains.

The relay (Fig.236) is a switching device with one pair of normally-closed contacts 5 and connecting wire 10 and Ш-shaped magnetic circuit (core 8). The relay consists of an electromagnet, armature 6 with movable contact 5, plastic panel 1 with pressed-in stationary contact bus-bars 4, return spring 14 and cap 16.

When the electromagnet winding is deenergized, movable contact 5 is pressed to the stationary contact under the action of return spring 16 and contact plate 7.

As winding 12 is energized, the electromagnet attracts the armature, and contacts 5 and 19 open.

Additional voltage relay P2 serves to shunt the series resistors connected in series with the contactor winding, when the voltage across the latter is less than the pickup voltage of relay P2.

Relay P2 is small in size and has one pair of normally-closed contacts. As to its design and operating principle, this relay is similar to auxiliary relay P4.

Auxiliary switching relay P1 (Fig.231) serves to change over the shunt winding of the differential relay from terminal MAINS (CETb) to the plus terminal of the generator.

Relay P1 (Fig.237) is of a switching, small-size, valve type with two pairs of normally-closed contacts and two pairs of normally-open contacts, and with a Ш-shaped magnetic

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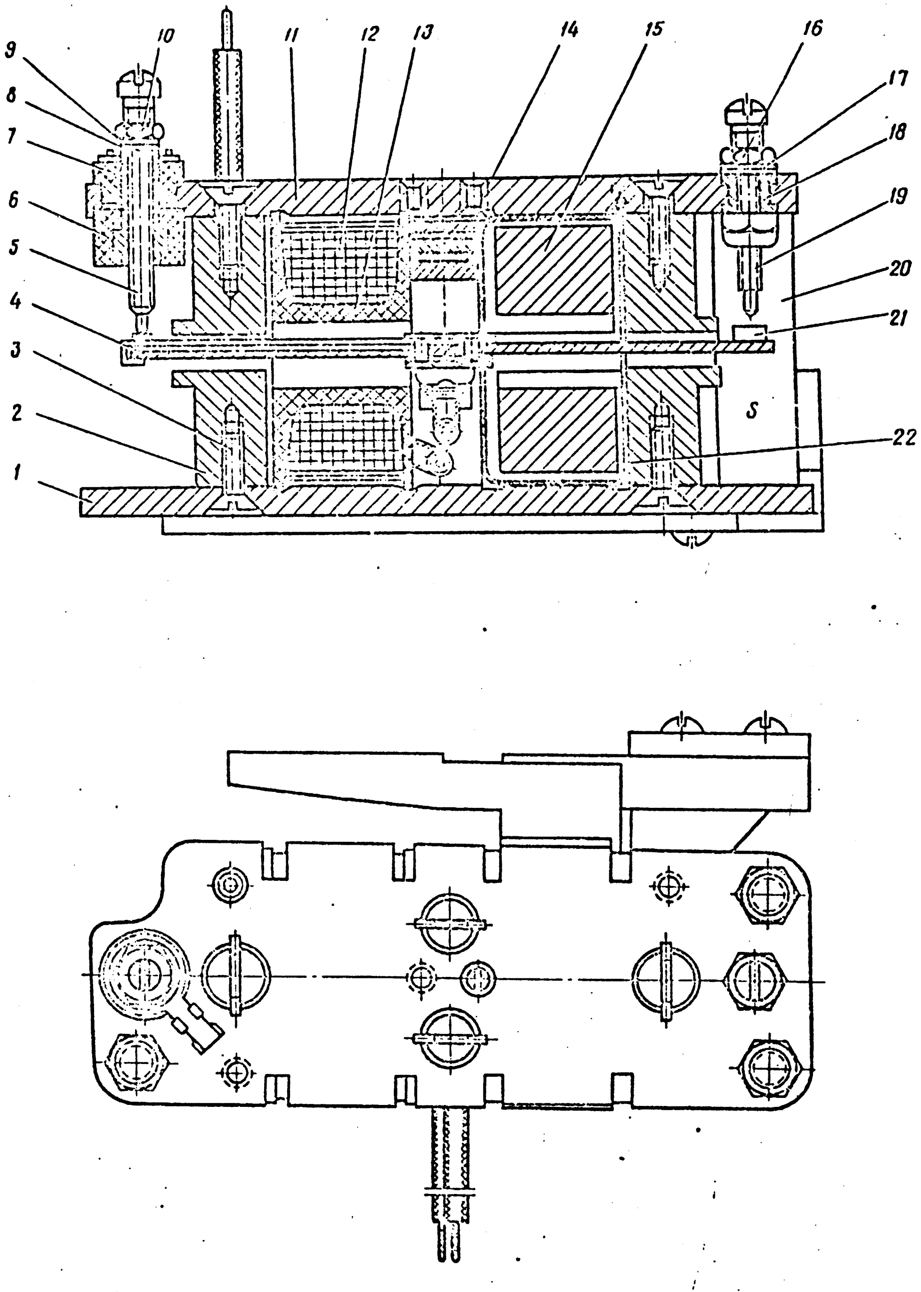
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FIG.234. DIFFERENTIAL CONTROL RELAY

1 - lower plate; 2 - pole; 3, 14 - screws; 4 - armature; 5 - contact screw; 6 - insulating bushing; 7 - bushing; 8 - protective washer; 9 - spring washer; 10 - locknut; 11 - upper plate; 12 - control winding; 13 - coil form; 15 - bus-bar; 16 - locknut; 17 - washer; 18 - nut; 19 - thrust screw; 20 - magnet; 21 - balance weight; 22 - insulating spacer

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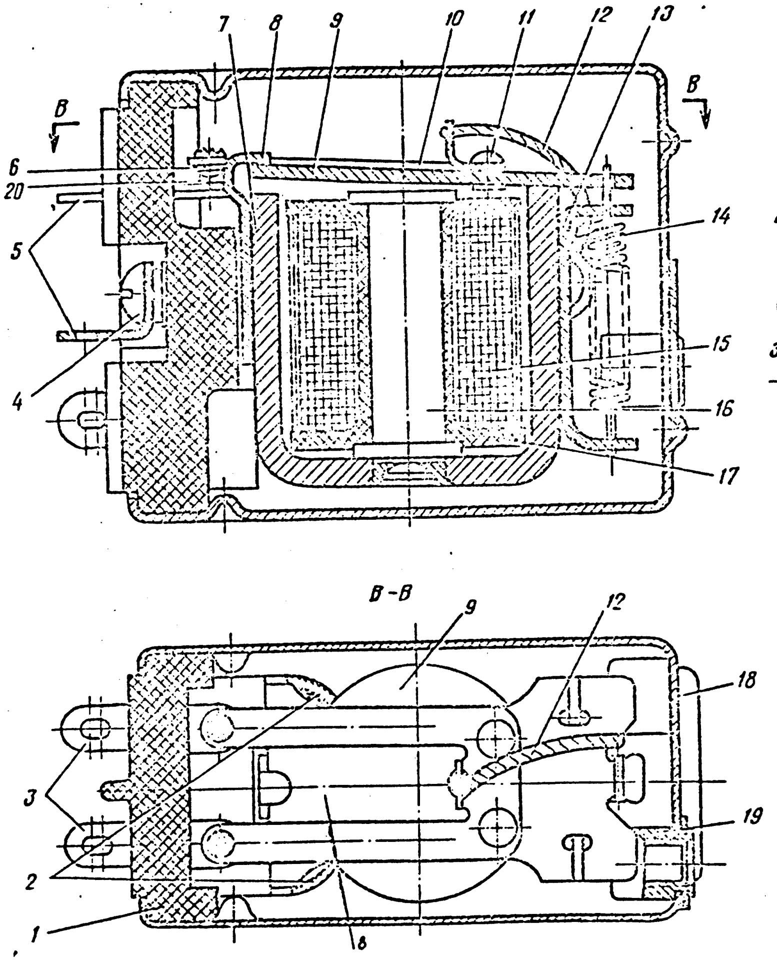
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FIG. 235. CUT-IN RELAY

1 - panel; 2 - coil lead; 3 - output bus-bars; 4 - screw; 5 - contact bus-bars; 6 - contacts; 7 - frame; 8 - stop; 9 - armature; 10 - contact plate; 11 - rivet; 12 - connecting wire; 13 - bracket; 14 - spring; 15 - winding; 16 - core; 17 - coil form; 18 - cap; 19 - bushing; 20 - stationary contacts

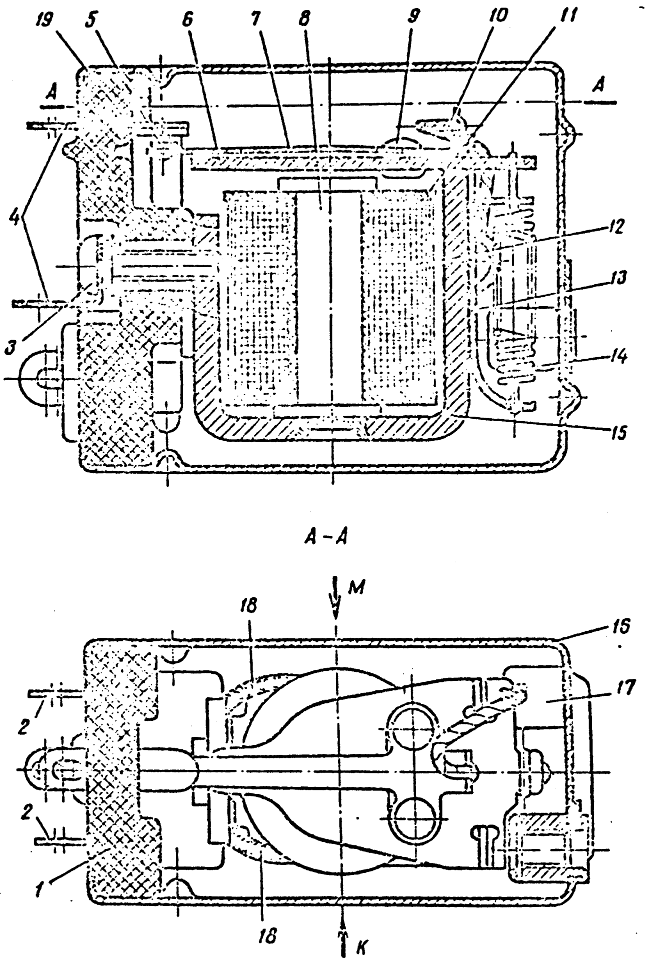
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FIG. 236. AUXILIARY RELAY

1 - panel; 2 - output bus-bars; 3 - screw; 4 - contact bus-bars; 5 - movable contact; 6 - armature; 7 - contact plate; 8 - core; 9 - rivet; 10 - connecting wire; 11 - coil form; 12 - winding; 13 - bracket; 14 - spring; 15 - frame; 16 - cap; 17 - bushing; 18 - coil leads; 19 - stationary contact

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circuit. The relay consists of an electromagnet, armature 9 with movable contacts 5, the panel with pressed-in stationary contact bus-bars 4 (fixed contacts), return spring 16 and cap 17.

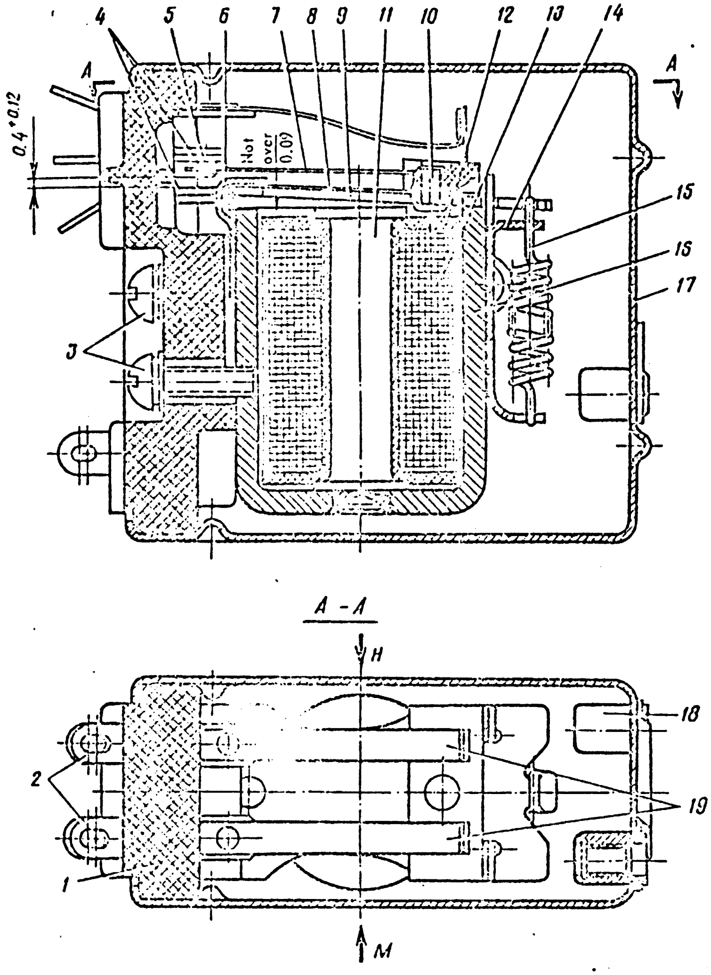

FIG.237. AUXILIARY SWITCHING RELAY

1 - panel; 2 - output bus-bars; 3 - screws; 4 - contact bus-bars (stationary contacts); 5 - movable contact; 6 - stop; 7 - contact plate; 8 - insulating plate; 9 - armature; 10 - rivet; 11 - core; 12 - coil form; 13 - winding; 14 - bracket; 15 - spring; 16 - frame; 17 - cap; 18 - bushing; 19 - connecting bus-bars

The voltage supplied to relay winding 13 induces a magnetic field under the action of which armature 9 is attracted to core 11. As a result, the upper pair of contacts opens, and the lower pair closes.

As the voltage across winding 13 decreases to a certain value, return spring 16 forces armature 9 to take up the initial position.

Differential minimum relay (Fig.231) operates as follows.

As switch B is closed, the winding of cut-in relay P3 is connected to the generator. As soon as the generator voltage reaches 14 V, the relay operates and contacts 1 - 2 of relay P3 close. In this case, the winding of auxiliary relay P4 and the shunt winding of control (differential) relay P5 are energized with the generator and battery voltage difference. If at the moment cut-in relay P3 picks up, the voltage difference reaches 12 - - 16 V, auxiliary relay P4 operates and opens contacts 1 - 2 and thus protects the control winding from continuous overload at a voltage exceeding 15 V the relay is rated for.

[redacted]

[redacted]

As the generator voltage rises, the difference between the generator voltage and battery voltage decreases, and as soon as it reaches 3 - 5 V, relay P4 drops out, contacts 1 - 2 close, and the winding of relay P5 is energized with the voltage difference.

If at the moment the winding of relay P5 is energized, the relay contacts are closed, the magnetic field induced by the winding will make the contacts open; if the contacts are open, they remain open under the action of the magnetic field.

When the generator voltage exceeds the battery voltage by 0.2 - 1 V, the magnetic field of differential relay P5 changes its direction and displaces the armature to a position at which the contacts are closed.

In this case, the contactor winding is energized with the generator voltage across contacts 1 - 3 of relay P3 and contacts 2 - 1 of additional voltage relay P2, the contactor operates and connects the generator to the mains across its power contacts. As the contacts are closed, the winding of the additional voltage relay is energized, the relay operates, opens its contacts 2 - 1 and connects additional resistor R in series with the contactor winding, resistor R considerably decreases the current in the contactor winding and thus prevents overheating of the latter.

Auxiliary switching relay P1 operates simultaneously with additional voltage relay P2 and changes over the end of the winding of control relay P5 from terminal MAINS to the generator terminal.

When the generator voltage decreases and becomes lower than the battery voltage, the current in series turn 1 of differential relay P5 changes its direction. As a result, the magnetic field of relay P5 reverses, and the armature is displaced to the opposite extreme position at which the contacts of relay P5 are opened, and the contactor disconnects the generator and relays P2 and P1 from the mains.

Differential winding 2 of the control relay is changed over from the generator terminal to terminal MAINS and shunted by the additional resistor. Relay P4 operates and breaks the circuit of the winding of relay P5.

If the generator voltage continues to decrease and becomes less than 5 V, relay P3 drops out and breaks the circuit of the winding of relay P4.

The contacts of relay P4 close, and the differential-minimum relay returns to the initial state.

9.2.4. Voltage Regulator PH-10

The vehicles of an earlier make are provided with voltage regulators P-27 whose operating principle is based on the ability of the carbon pile (assembled of carbon discs) to change its resistance as a function of the compressive force.

The vehicles of a later make are provided with semiconductor voltage regulator PH-10 (Fig.238).

The voltage regulator is designed to keep the generator voltage within the predetermined limits when the rotational speed of the generator armature varies. It also protects the consumers from damage when the regulator elements fail under emergency operating conditions. The regulator is of a contactless type. It employs the properties of semiconductor devices: transistors (triodes) and stabilitrons (diodes). The transistor changes its resistance in a wide range when the polarity and value of the voltage applied to the emitter-base terminals are changed. The transistor connected to the generator field winding automatically reverses the control voltage polarity and changes its value, thus automatically changing the exciting current as a function of the armature rotational speed and maintaining the preset voltage.

The stabilitron is a silicon diode that possesses a low conductance and practically does not pass the current on the condition the voltage applied to the stabilitron in a reverse direction does not exceed a certain value. Beginning from a certain voltage which is called a stabilizing voltage, the stabilitron conductance sharply increases and the stabilitron passes the current, the latter considerably increases practically at a constant voltage. This property is used to control the transistor.

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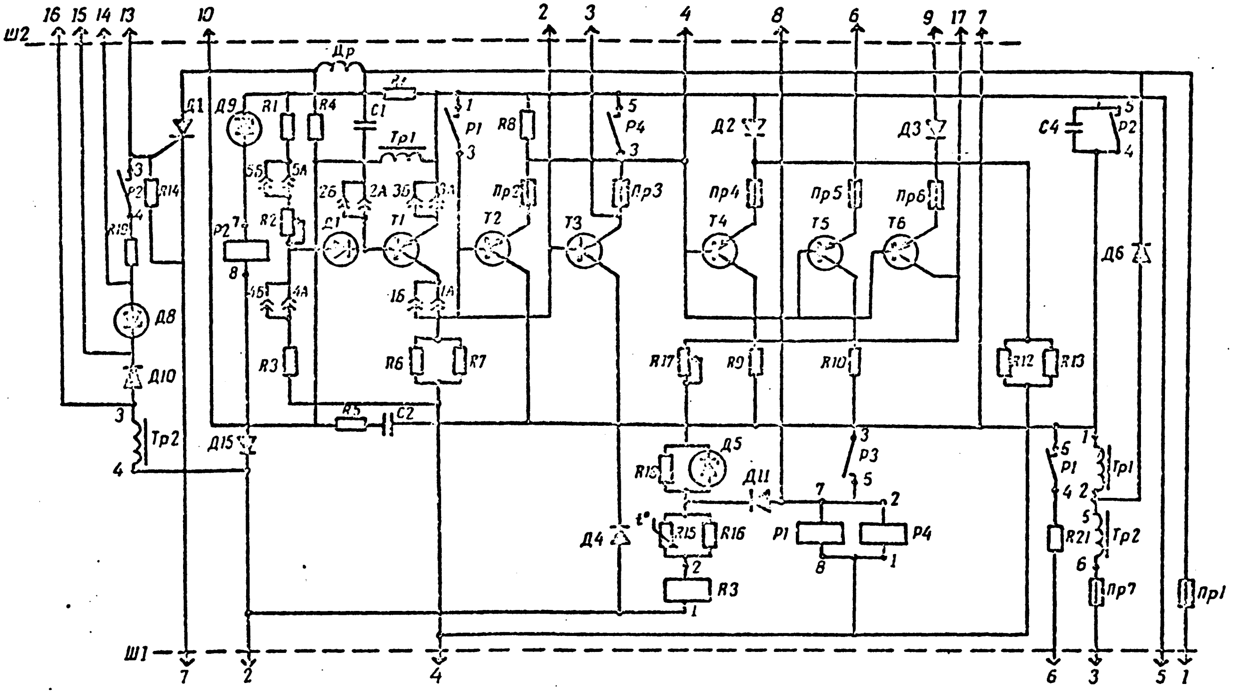
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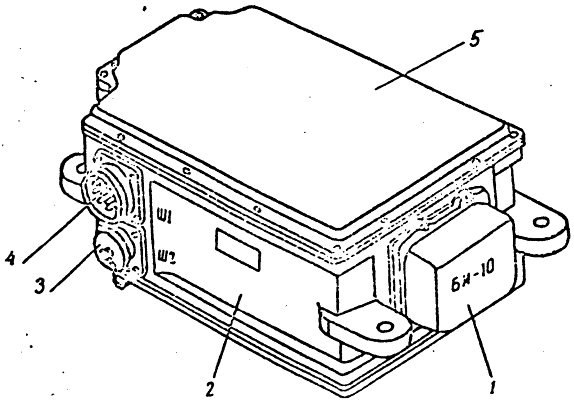
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FIG.238. GENERAL VIEW AND SCHEMATIC CIRCUIT DIAGRAM OF VOLTAGE REGULATOR PH-10

1 - measurement unit; 2 - regulator body; 3 - plug connector; 4 - plug connector; 5 - cover; Д1 - silicon stabilitron of measuring device (type Д814А); Д2 and Д3 - silicon diodes of regulating device (type Д231); Д4 and Д6 - silicon diodes (type Д231); Д5 - silicon stabilitron of voltage protection system (type Д814Д); Д7 - thyristor of short-circuit protection system (type Д223Б); 8 - silicon stabilitron of short-circuit protection system; Д9 - stabilitron; Д10 - diode of short-circuit protection system; Д11 and Д15 - silicon diodes; R1-100-ohm resistor of measuring device; R2 - variable resistor of measuring device; R3-240-ohm resistor; R4-31.2-ohm resistor; R5-1.5-kohm resistor; R6, R7, R12 and R13-510-ohm resistors; R8-20.5-ohm resistor; R17-220-ohm resistor; R18-300-ohm resistor; R21-10-ohm resistor; R_f - feedback resistor (GOST 2238-52); Др - air choke; T1 - germanium transistor of measurement unit (type П-215); T2 and T3 - germanium transistors in composite transistor (type П-215) of regulating device; T4, T5 and T6 - germanium transistors in composite transistor of regulating device (type П-210А); Пр1, Пр2, Пр3, Пр4, Пр5, Пр6 and Пр7 - safety fuses; P1 - electromagnetic relay (type РЭС-22); P2 - electromagnetic relay (type РЭС-6); P3 - electromagnetic relay (type РЭС-10); P4 - two-winding electromagnetic relay; C1-20-μF capacitor; C2-0.5-μF capacitor; C4 - capacitor; 7, 2, 4, 6, 3, 5 and 1 - contactors of plug connector Ш1; 16, 15, 14, 13, 10, 2, 3, 4, 8, 6, 9, 17, 7 - contacts of plug connector Ш2

The regulator is mounted in the battery compartment on the flange. The regulator is noted for the method of generator voltage regulation by means of the controllable transistor connected to the generator field circuit as a variable resistor.

The regulator is enclosed in aluminum housing 2 closed by two covers 5. The housing mounts measurement unit 1 and plug connectors 3 and 4 (Ш1 and Ш2); plug connector Ш1 serves to connect the regulator with the mains, and plug connector Ш2, to check the electric wiring. The side wall of the housing carries a plate with safety fuses closed with a cover.

The regulator consists of the following basic components:

- measuring device ИУ;
- regulating device РУ;
- protection circuit elements.

Measuring device employs a bridge circuit with controllable transistor T, silicon stabilitron Д1, eight resistors R1 - R7 and R_f and two capacitors C1 and C2.

Resistors R1, R2 and R3 represent the resistors of a voltage divider. Resistor R2 serves to adjust the generator output voltage. Resistor R_f provides an exciting current feedback to compensate for variation of the controlled voltage, caused by changes in the rotational speed of the generator armature and generator load; this resistor also serves to accelerate the change-over of the transistors.

Resistors R6 and R7 are the load resistors of transistor T1. The circuit consisting of resistor R5 and capacitor C2 accelerates the change-over of transistor T1.

Capacitor 1 suppresses the high-frequency voltage ripples at the input of transistor T1.

The measuring device is made as a separate unit independently of the regulator.

Regulating device includes composite transistor T2 - T6, resistors R8, R9, R10, transformer Tp1, diodes Д2 and Д3 loaded into resistors R12 and R13, and power transistors T4, T5 and T6. The use of the composite transistor provides for increase of the gain factor of the regulating device and thus reduces the power consumed by the measuring device.

Feedback transistor Tp1 increases the transistor changeover frequency.

Resistors R9 and R10 drive transistors T2 and T6 to operate in a switching mode.

Regulator operates as follows. With the engine shut down, all the regulator circuits are deenergized. Generator self-excitation is possible due to residual magnetism of the poles. In this case, the input voltage of the measuring device, which is, in fact, the generator voltage, is low, and transistor T1 (Fig.238) is cut off. The output voltage of transistor T1 is practically equal to the generator voltage; it serves to make composite transistor T2 - T6 become conductive.

So, the composite transistor is conductive, and its circuits pass the generator exciting current.

Diodes Д2 and Д3 provided in the exciting circuit hamper self-excitation of the generator at the initial speed. The undesirable effect of the diodes is neutralized by relay P2 whose normally-closed contacts shunt the output of the composite transistor and thus ensure reliable self-excitation of the generator. At the generator voltage of 10 - 20 V, the contacts of relay P2 open, and further operation of the generator is controlled by the measuring device.

As soon as the generator voltage reaches the rated value (14 V), the conductance of stabilitron Д1 sharply increases (the stabilitron gets broken-down), thus abruptly increasing the input voltage of transistor T1. The latter gets conductive, its output voltage sharply decreases, and as a result, composite transistor T2 - T6 is cut off. The internal impedance of power transistors T4, T5 and T6 abruptly rises, thus limiting the exciting current.

To eliminate overvoltages appearing in transistors T2 - T6 at a high rate of exciting current decrease, the generator field winding is shunted by diode Д4 which serves to damp the field winding self-inductance electromotive force.

[redacted]

[redacted]

As the generator voltage decreases, stabilitron Д1 reverts to the original state; as a value required to turn on the composite transistor. Thus, the composite transistor is alternately turned on and off.

The regulator automatically sets the ratio of conducting time to non-conducting time of the composite transistor connected to the exciting circuit at which the generator voltage is kept within the preset limits.

The given generator voltage control circuit makes the power transistors operate as a switch when there are two stationary states of the transistor: conducting and non-conducting.

The voltage protection circuit serves to make the regulator more dependable. The circuit puts out of operation any of transistors T2 - T6 if it fails (if the collector-emitter junction is broken down). It includes relays P1, P3 and P4, resistors R15, R17, R18 and R21, stabilitron Д5 and diode Д11.

The voltage protection circuit is connected in parallel with the generator field winding and adjusted for the operating voltage of 29.5 - 33.0 V by resistor R17.

If any of transistors T2 - T6 fails (the resistance of the collector-emitter junction is equal to zero), the voltage across the field winding sharply rises.

As soon as the voltage across the field winding becomes equal to 29.5 - 33.0 V, relays P3, P1 and P4 are caused to operate.

The contacts of these relays close and make a circuit through which a voltage is applied to the safety fuse of the faulty transistor and the safety fuse blows out. This circuit is the following: contact 1 of plug connector Ш1/1, safety fuse Пр1, resistor R_f safety fuse in the circuit of the faulty transistor (T2 - T6), transistor, contacts of relay P1, resistor R21 and contact 6 of plug connector Ш1/6 (contact 1 of plug connector Ш1 is connected with the generator plus and contact 6, with the body).

As the safety fuse blows and breaks the circuit, the faulty transistor is put out of operation. The regulator continues to maintain the generator voltage within the preset limits. Contacts 5 [illegible] of relay P4 connected to the base of the composite transistor turn off the serviceable transistors for the period during which the safety fuse blows out.

The circuit designed to protect the regulator when the generator field winding is closed to body, includes the following elements: resistors R14 and R19, diode Д10, stabilitron Д8, transformer Tp2 and safety fuses Пр1 and Пр7.

The thyristor is a silicon four-layer semiconductor device rated for a lower lagging as compared with the transistor.

As the generator field winding is closed to "body", the current flowing through the primary winding of transformer Tp2 sharply rises and the thyristor is turned on by the signal appearing in the control circuit of thyristor Д7. The thyristor gets conductive through the circuit: generator plus, contact 1 of plug connector Ш1, safety fuse Пр1, choke Др, thyristor Д7, and contact 7 of plug connector and "body".

Safety fuse Пр1 blows out, disconnecting the regulator from the generator.

The circuit also prevents failure of the regulator when the generator field winding is closed to generator terminal "Л". As a result, the voltage in the field winding sharply rises, and the voltage protection circuit operates. Contacts 5 and 3 of relay P4 open and turn off the composite transistor. Contacts 6 and 4 of relay P1 close and make the following circuit: contact 3 of plug connector Ш1, safety fuse Пр7, transformer Tp2, transformer Tp1, contacts 6 and 4 of relay P1, resistor P21, contact 6 of plug connector Ш1 and body.

As the current passes via this circuit, safety fuse Пр7 blows out, as a result an opening signal is sent to the control circuit of thyristor Д7 and it gets conductive. The following circuit is made: generator plus, contact 1 of plug connector Ш1, safety fuse Пр1, choke Др, thyristor Д7, contact 2 of plug connector Ш1 and body. As the current flows through this circuit, safety fuse Пр1 blows out, and the regulator is disconnected from the mains.

The schematic circuit showing connection of differential-minimum relay ДМР-400Т and voltage regulator РН-10 to mains is presented in Fig.239.

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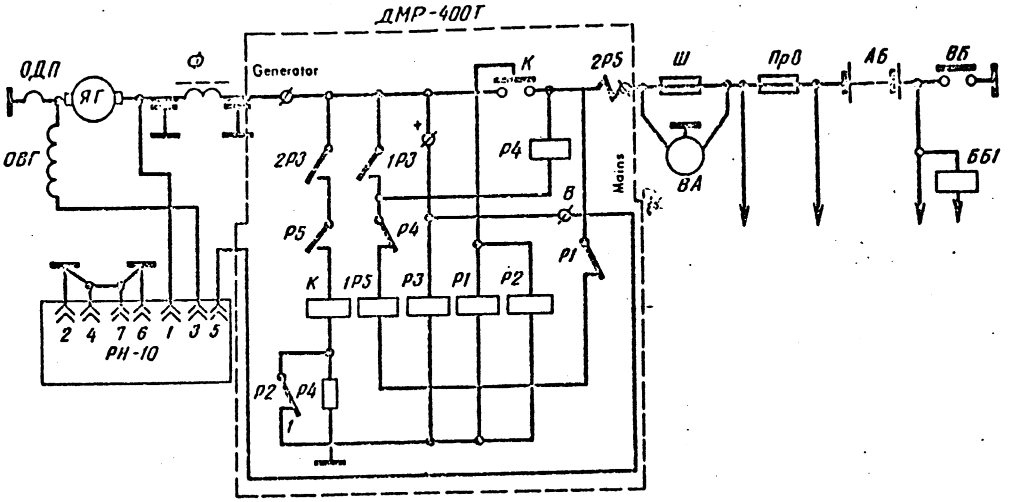

FIG.239. SCHEMATIC CIRCUIT DIAGRAM OF POWER SOURCE CIRCUITS

ОВГ - generating field winding; ОДП - generator commutating winding; ЯГ - generator armature; PH-10 - voltage regulator; Ф - radio interference filter; ДМР-400T - differential minimum relay; K - generator starting contact; P1, P2, P3 and P4 - switching relays; P5 - differential relay; 1P5 - winding of differential relay; 2P5 - series turn of differential winding; BA - voltammeter; Ш - voltammeter shunt; Пр8 - safety fuse; АБ - storage battery; ВБ - battery switch; ББ1 - battery contactor

9.3. ELECTRIC POWER CONSUMERS

9.3.1. Electric Starter C-5

The electric starter (Fig.240) is intended to start the engine. The starter is a D.C. series-excited electric motor with an inertia-type drive with friction clutch. The starter gear is engaged with the teeth of the flywheel rim. The direction of starter rotation is right-hand (clockwise) as viewed from the drive side.

The main components of the starter are: frame 31, commutator end head 29, drive end head 40 and armature 33.

The frame represents a hollow cylinder; attached to the inside of the frame are poles 32 with exciting coils 20; the poles are stacks of electrical sheets. The coil pairs are connected in parallel and in series. Two ends of the exciting winding are connected to terminal bolt 15 secured on the starter frame, and the remaining ends, to the plus brushes.

Commutator end head 29 holds radial shielded ball bearing 26 with protective washers and two brush holders 24 for plus brushes 21. The brush holders are insulated from the head with gaskets 25.

The starter drive built in drive end head 40 consists of friction clutch 11, shank 8 and two spherical ball bearings 6 which are fitted on bronze bushing 42.

Body 36 of friction clutch 11, cup 39 and driving discs are connected with starter armature shaft 9, and bushing 10 and the driven discs are connected with shank 8.

Prior to installation the discs are coated with a thin layer of graphite grease. The discs rest on pressure ring 38 and safety washers 37. Spring 12 provides precompression of the disc stack. Placed between the body and shank is buffer spring 35. Shank 8 is held in the clutch by half-rings. The shank is retained by a special lock consisting of thrust bushing 43, bushing 2, spring 1, collar 45 on the end of armature shaft 9.

Starter armature 33 consists of a toothed core and commutator 27 fitted on a common shaft. The core is composed of electrical steel sheets. The armature has an intersecting right-hand winding and the shaft has a right-hand thread. The commutator is of an ordinary cylindrical type.

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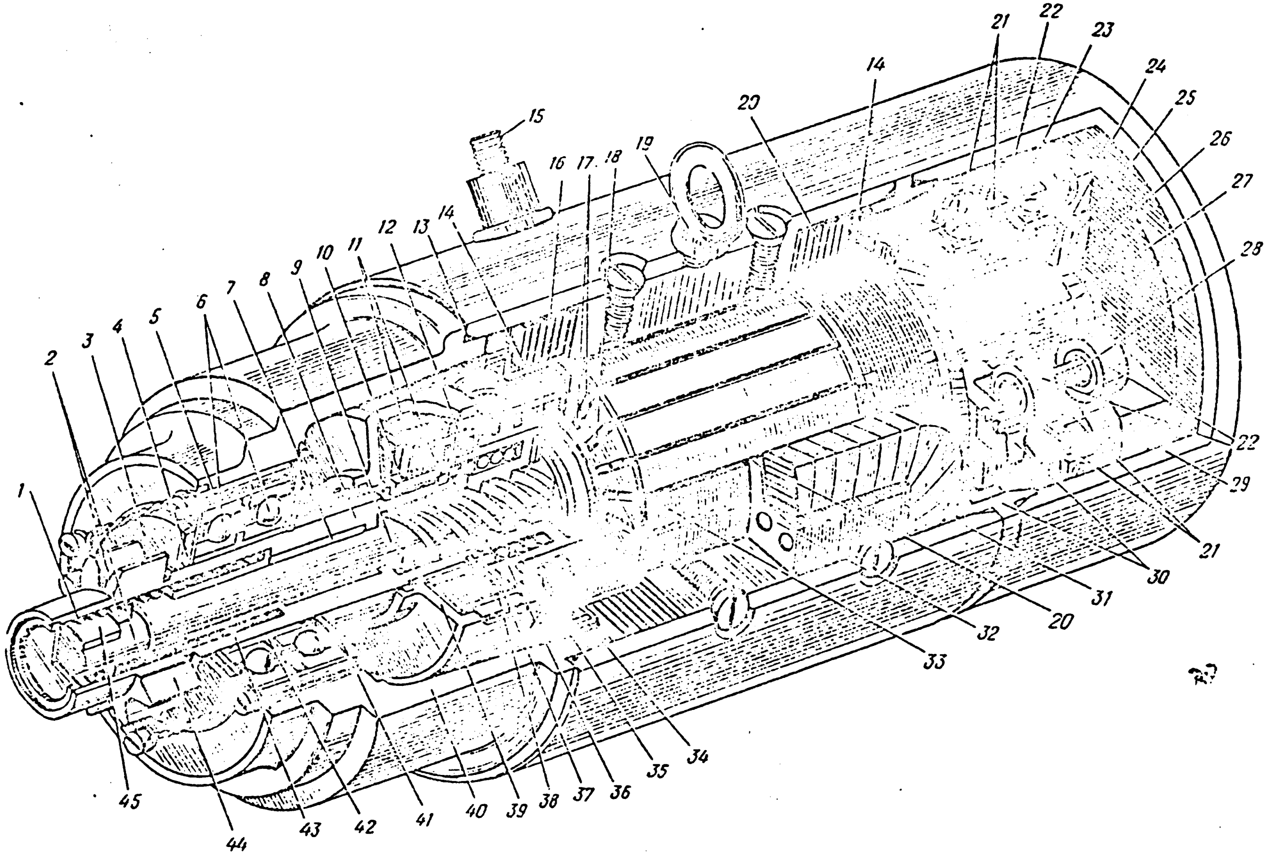
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FIG.240. ELECTRIC STARTER C-5

1 - return spring; 2 - bushing; 3 - disc washer; 4 - sealing washer, 5 - stud; 6 - ball bearing; 7 - bronze bushing; 8 - shank; 9 - shaft; 10 - bushing; 11 - friction clutch; 12 - friction clutch spring; 13 - sealing ring; 14 - bandage; 15 - terminal bolt; 16 - washer; 17 - armature winding; 18 - insulating spacer; 19 - eye-bolt; 20 - stator winding (coil); 21 - brushes; 22 - brush spring; 23 - bus-bar; 24 - brush holder; 25 - gasket; 26 - ball bearing; 27 - commutator; 28 - brush holder post; 29 - commutator end head; 30 - ring; 31 - frame; 32 - pole; 33 - starter armature; 34 - bus-bar; 35 - buffer spring; 36 - clutch body; 37 - safety washers; 38 - pressure ring; 39 - outer cup; 40 - drive end head; 41 - washer; 42 - bushing; 43 - thrust bushing; 44 - starter gear; 45 - collar on armature shaft

[redacted]

[redacted]

The commutator end head and the drive end head are inserted in the starter frame and secured with two studs. An aluminum casing is fitted on the commutator end head and attached to the latter with two bolts having rubber sealing rings. The casing-to-commutator end head joint and the starter frame-to-drive end head joint are sealed with rubber rings, and the starter frame-to-drive end head joint is packed with sealing compound.

The starter operates as follows.

When full voltage (24 V) is applied to the starter, the starter armature begins to revolve with a high angular acceleration, while the drive tends to retain its position due to inertia forces; therefore, the rotational speed of the drive is less than that of the armature shaft.

As a result, the drive comes off the shaft over a spiral groove; it moves along the shaft axis until the shank gear engages the flywheel rim. After that the gear keeps on moving until thrust bushing 43 comes to touch bushing 2. During rotation of the drive, friction clutch body 36 compresses buffer spring 35 and the friction discs. Pressure ring 38 presses with its outer shoulder on washers 37, thus deflecting them and compressing the discs (the compression force is equal to the reaction of the deflected washers). The higher the moment transmitted by clutch 11 the greater is the deflection of washers 37. The force compressing the discs rises until bushing 10 thrusts with its end face against the washers. When in the extreme left-hand position, the bushing limits the deflection of the washers, and consequently the torque transmitted by the drive. Further increase of the torque causes slippage of the compressed discs.

After the engine starting, starter gear 44 serves as a driven gear, and the direction of the axial force is reversed. As a result, and also due to the force of return spring 1, starter gear 44 is disengaged from the flywheel.

In case the gear sticks against the flywheel teeth end faces, it stops to move for some time, but the clutch body continues to move along the spiral groove under the action of buffer spring 35, turns the starter gear by half the distance between the teeth, thus providing engagement of the gear with the flywheel.

The starter is mounted in the bed of the cylinder block-and-crankcase unit and secured with two half-hoops 5 (Fig.241). It is held against rotation about its axis by pin 4 press-fitted into the bed.

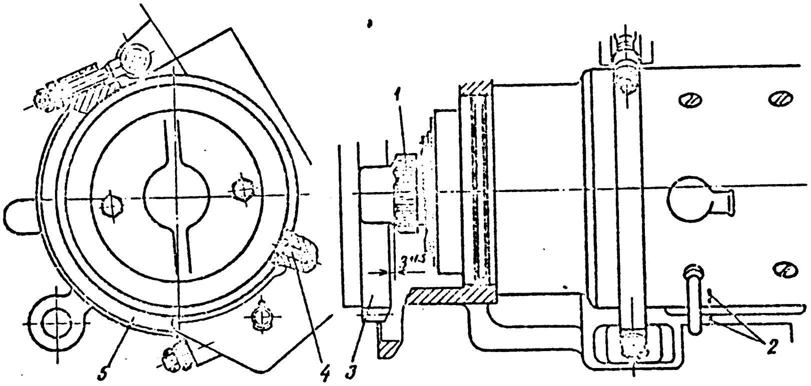

FIG.241. ELECTRIC STARTER MOUNTING
1 - startc. gear; 2 - marks; 3 - engine flywheel; 4 - pin; 5 - half-hoop

[redacted]

The starter must be so positioned in the axial direction that the clearance between starter gear 1 in the initial position and flywheel rim 3 is within 3 - 4.5 mm.

Marks 2 provided on the starter frame and on the bed of the cylinder block-and-crankcase unit make it possible to properly position the starter in the longitudinal direction.

The backlash between the teeth of the starter gear and flywheel rim is within 0.6 - 1.0 mm.

9.3.2. Starter Contactor КМ-600Д-В

The starter is connected to the vehicle mains as shown in Fig. 242. The starter is connected through contactor КМ-600Д-В supplying the current from the plus terminal of the storage batteries to the starter terminal.

The contactor is switched on by means of the button located on the central panel. The starter contactor is similar to the storage battery contactor both in design and operating principle.

The contactor is, in fact, a tractive electromagnet consisting of cylindrical housing 13, electromagnet with pull-in winding 2 and holding winding 1, armature 3 with rod 12, stationary contacts 7, pressed into plate 4, movable contacts 8, secured on the upper end of rod 12, two springs, two power terminal bolts 5 and 11, two control terminal bolts 10 and two contacts 16 of the pull-in winding.

Besides, provision is made for two contacts КМ-50Д-В for opening and closing the circuits of priming pump МЗН-2 and the preheater glow plug. They differ from contactor КМ-600Д-В in characteristics only.

The contactor operates as follows.

On pressing starter button 17 (with battery contactor 20 switched on), the battery current passes through starter button 17 to control terminal bolt 10 where it is branched off: part of the current passes through the holding and pull-in windings to the body, and part of the current flows through the holding winding and normally-closed contacts 16 to the body. Under the action of the magnetic field the armature is pulled in, thus opening contacts 16 and closing contacts 7. The battery current passes through terminal bolt 5, closed contacts 7 to the terminal of starter 22; then, the current passes through the series windings of the poles to the plus brushes, commutator, minus brushes and body. Owing to such current paths, the consumption of the current flowing via the contactor windings, is reduced, the resistance of the circuit is increased, and consequently the starting conditions are improved.

9.3.3. Electric Motors

Electric motor МВ-67 (Fig. 243) serves to drive the special blower of the filter-ventilating unit. The connection circuit is of a single-wire type.

The electric motor is a D.C. compound-wound machine rated for 800 W. The rated rotational speed is 7000 rpm, and the current consumption is not more than 55 A.

The electric motor consists of hollow cylindrical frame 13 with two end shields 9 and 14, armature 12, four poles secured with sunk screws, two coils 19 with series windings and two coils with shunt windings, brush holders with four brushes 1. Access to the brushes and commutator is provided through the holes closed with protective band 10. The end shields are attached to the frame with coupling studs 8. The armature is a stack of electrical steel sheets fitted on a shaft whose slots hold a winding. The ends of the armature windings are connected to the bars of commutator 20 fitted on the end of the armature shaft.

With the electric motor energized, the current passes through the field windings and armature windings and produces electromagnetic fields. As a result of interaction of those fields, the armature starts revolving.

The vehicle is equipped with two electric motors МПП-2. One of them serves to drive the front water drainage pump, and the other, to drive the rear water drainage pump and the pump of the smoke-generating system.

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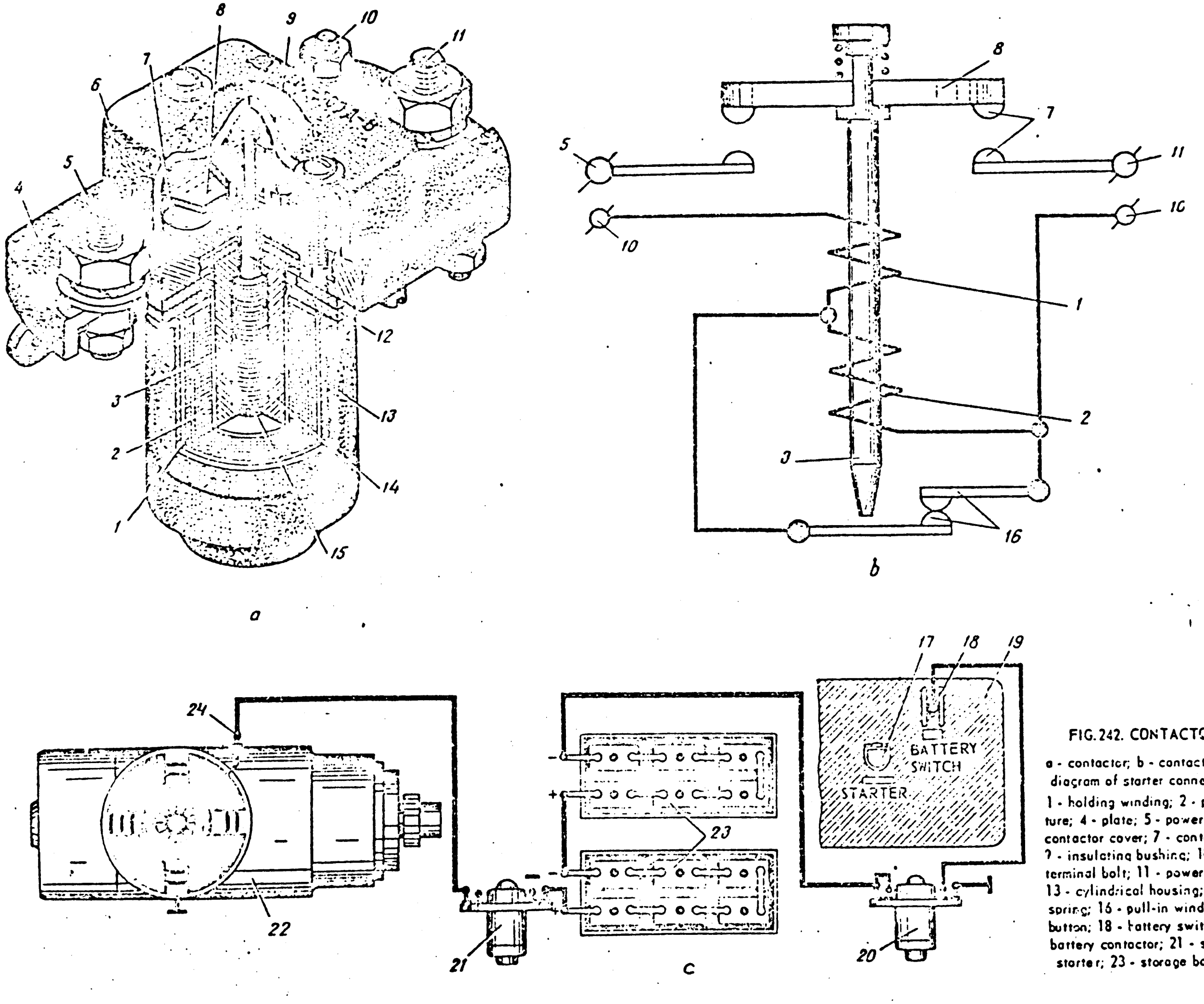
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SWITCH
STARTER
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FIG. 242. CONTACTOR KM-600Д-B

a - contactor; b - contactor operation diagram; c - diagram of starter connection to mains

1 - holding winding; 2 - pull-in winding; 3 - armature; 4 - plate; 5 - power terminal bolt; 6 - contactor cover; 7 - contacts; 8 - movable contact; 9 - insulating bushing; 10 - control circuit power terminal bolt; 11 - power terminal bolt; 12 - rod; 13 - cylindrical housing; 14 - magnetic circuit; 15 - spring; 16 - pull-in winding contacts; 17 - starter button; 18 - battery switch; 19 - central panel; 20 - battery contactor; 21 - starter contactor; 22 - starter; 23 - storage batteries; 24 - starter lead

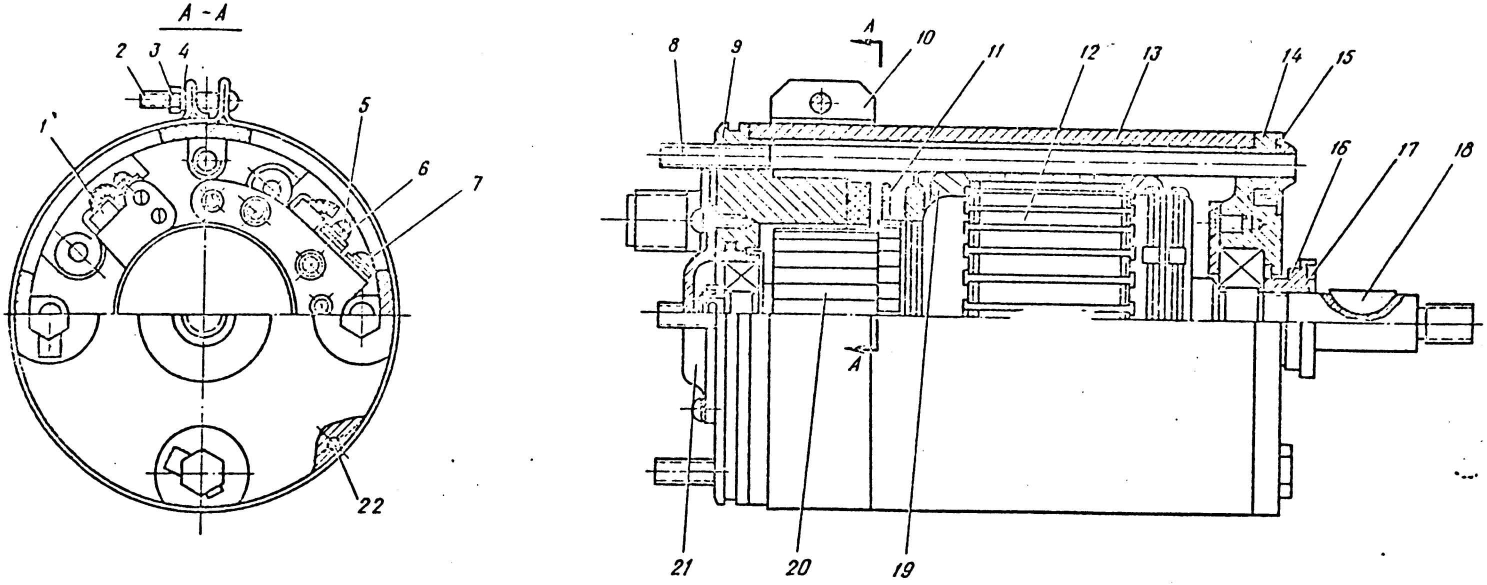
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FIG.243. ELECTRIC MOTOR MB-67

1 - brush; 2 - protective band screw; 3, 16 - nuts; 4 - spring washer; 5 - brush holder screw; 6 - spring washer; 7 - screw; 8 - coupling stud; 9 - commutator end shield; 10 - protective band; 11 - jumper; 12 - armature; 13 - motor frame; 14 - drive end shield; 15 - tab washer; 16 - nut; 17 - sealing ring; 18 - semi-circular key; 19 - coil; 20 - commutator; 21 - cover; 22 - lockpin

[redacted]

The electric motor is a D.C. compound machine. Rated output - 300 W, rated rotational speed - 3400 rpm, and current consumption - 24 A. The connection circuit is of a two-wire type.

Unlike other motors, all the four poles of this motor have series and shunt windings. The motor is water-tight.

The inner space of the motor communicates with the atmosphere through a pipe union on which a rubber pipe is fitted. The electric motors are started by switches WATER DRAINAGE FRONT, REAR and SM.GEN.SYST. (ТДА) located on the central panel.

Electric motor МЕП-2 does not differ from electric motor МВ-67 in the design and operating principle.

✓ Electric motor МН-1 is designed to drive oil priming pump МЗН-3.

The motor is a four-pole, series-excited D.C. machine employing a two-wire circuit. Output - 500 W, rotational speed - 3100 rpm,current consumption - not more than 40 A.

As to its design and operating principle, electric motor МН-1 resembles the above-mentioned motors.

The motor is started by button МЗН located on the central panel.

Electric motor МУ-431 is a small-size four-pole series-excited closed flange-type reversible D.C. machine having two separate field windings. Output - 400 W, rotational spee - 5000 rpm, current consumption - not more than 32 A.

The vehicle is equipped with three electric motors of the МУ-431 type. One motor is designed to lift and lower the levers of the loading mechanism, the second motor is used to turn the loading mechanism conveyor, and the third motor is intended to ram the rounds.

The electric motors are started and stopped automatically as described in Subsection 3.2. "Loading Mechanism". Besides, the electric motors of the conveyor and loading mechanism levers may be started by the buttons arranged on the turret board.

Electric motor Д-100 is designed to drive fuel feed pump БЦН.

The electric motor is a four-pole series-excited D.C. machine employing a single-wire circuit. Output - 150 W, rotational speed - 5800 rpm, and current consumption - not more than 5.8 A.

The boost is obtained by shunting the series field winding by means of rheostat РБП-45.

The motor is started by switch "БЦН" provided on the central panel.

Electric motor Д-55 is a two-pole series-excited D.C. machine. Output - 55 W, rotatio speed - 4500 rpm, and current consumption - not more than 4 A.

The vehicle is provided with four electric motors Д-55. The electric motors serve to drive three exhaust blowers of the hull and turret, as well as the blower of the troop compartment heater.

The exhaust blower motor is started and stopped by the handle secured on the blower housing by means of an axle.

For the description of the design and operation of the exhaust blower motor starting mechanism see Subsection 11.3.

The electric motor of the troop compartment heater blower is started by switch 18 (Fig.227) located on the rear wall of the battery compartment.

Electric motor МПБ-3Н serves to drive the preheater pump unit. It is a four pole seri excited non-reversible closed flange-type machine employing a single-wire circuit. Outpu - 164 W, rotational speed - 7800 rpm, rated current consumption - 10 A.

The electric motor is started by switch ENG.HEATING on the central panel.

All the above-mentioned electric motors are similar in their design and operating principle to electric motor МВ-67 described above.

9.3.4. Lighting and Light Signalling Devices

The vehicle has lighting devices (external and internal) and light signalling devices. Besides, provision is made for service lights connected to the vehicle mains through a two-circuit.

[redacted]

vance of the blackout measures. It is installed on the hull upper front plate of the left side of the vehicle.

The headlight consists of body 8 beam unit and fastening parts.

The beam unit assembly is attached to the headlight body with the help of rim 5; the beam unit is fastened to the latter with spring holders and four screws 10.

The beam unit comprises reflector 7, casing 13, casing holder 12, lamp with holder 14, and lens 2.

The beam unit is sealed with rubber gasket 3 and screws 16 clamping rim 5 to ring 4.

Placed between the headlight body and the beam unit is rubber sealing ring 6. The neck of reflector 7 is sealed in casing 13 by means of rubber gasket 9.

Inserted into the casing is receptacle 11 which supplies the current to lamp 14 (28 V, 40 W).

The headlight is secured on a bracket by means of bolt 15.

The blackout device consists of a blackout attachment, blackout switch ППН-45 and resistor ПЭ-50.

The blackout attachment is round metal disc 19 having a visor and a shield. It is attached to the headlight body.

In the upper part of the disc there are two narrow slots shielded by a double visor. From beneath the visor is covered with a shield which prevents illumination of the vehicle front. The lower part represents hinged cover 17 which can be fixed in the lower and upper positions by spring-loaded retainers.

The blackout device provides for three blackout duties:

- full blackout: cover 17 is in the lower position, closing the lower part of the lens; additional resistor ПЭ-50 (10 ohms) is connected to the lamp supply circuit. The resistor is turned on by switch ППН-45 (HEADLIGHT СМУ) which is mounted on the central panel. For this purpose, the switch is placed in position "М";
- partial blackout: cover 17 is in the lower position, the resistor is cut off, and the lamp burns at full glow;
- full light: cover 17 is thrown up and the lamp burns at full glow.

Infrared headlight ФГ-125 is designed for operation at night with driver's vision device ТВНО-2. The headlight is installed on the right side of the front plate of the hull. It is similar in design to headlight ФГ-127, but unlike headlight ФГ-127, it has an infrared filter, but has no blackout device. The headlight is turned on by switch "ТВН" arranged on the central panel.

Headlight ФГ-126 is designed to illuminate the path ahead of the vehicle at night when afloat in case the main headlight ФГ-127 is of no use because of water splashes.

The headlight is mounted on the right side the of turret roof.

This headlight is similar in design to the above-mentioned headlights, but unlike the latter it has no light filter and blackout device.

The headlight is turned on by the switch located on the turret board.

Marker lights ГСТ-64 are designed to show the vehicle dimensions at night and under conditions of poor visibility. They are turned on during movement and at halts.

There are six marker lights on the vehicle. Two front lights have a green light filter, two side lights have a yellow light filter, and two rear lights have a red light filter. All the lights are similar in design.

The marker light consists of body 5 (Fig.245) with cover 3 and gasket 4, holder 6 with lamp 12, frosted glass 1 and light filter 2, spiral spring 7 secured in the light body, and fastening parts. The holder is screwed into spring 7 which serves as a shock absorber. The marker lights are secured with the help of bolts 9 having spring washer 8.

Lamp supply wire 11 passes through bolt 9. The wire is sealed with a rubber bushing pressed by nut 10.

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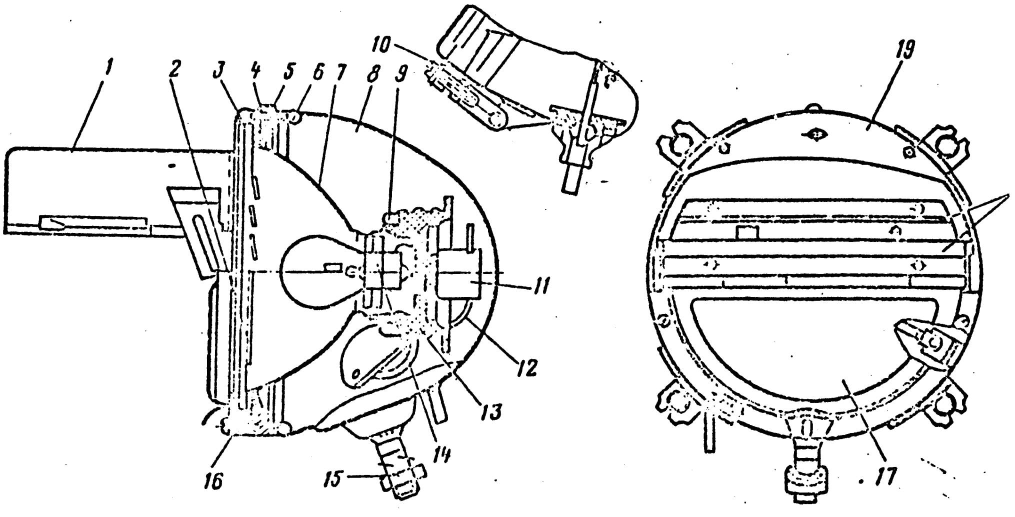
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FIG. 244. HEADLIGHT ФГ-127

1 - blackout attachment; 2 - lens; 3 - rubber gasket; 4 - ring; 5 - rim; 6 - rubber ring; 7 - reflector; 8 - headlight body; 9 - gasket; 10 - beam unit securing screw; 11 - receptacle; 12 - casing holder; 13 - casing; 14 - lamp with holder; 15 - securing bolt; 16 - screw; 17 - cover; 18 - slots in disc; 19 - blackout attachment disc

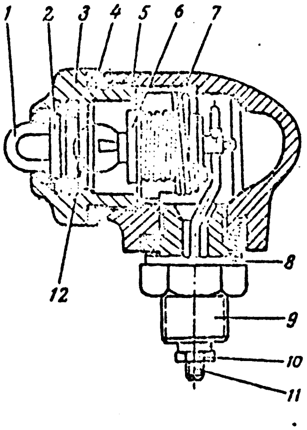
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FIG. 245. MARKER LIGHT

1 - frosted glass; 2 - light filter; 3 - cover; 4 - gasket; 5 - body; 6 - holder; 7 - spring; 8 - washer; 9 - bolt; 10 - nut; 11 - wire; 12 - lamp

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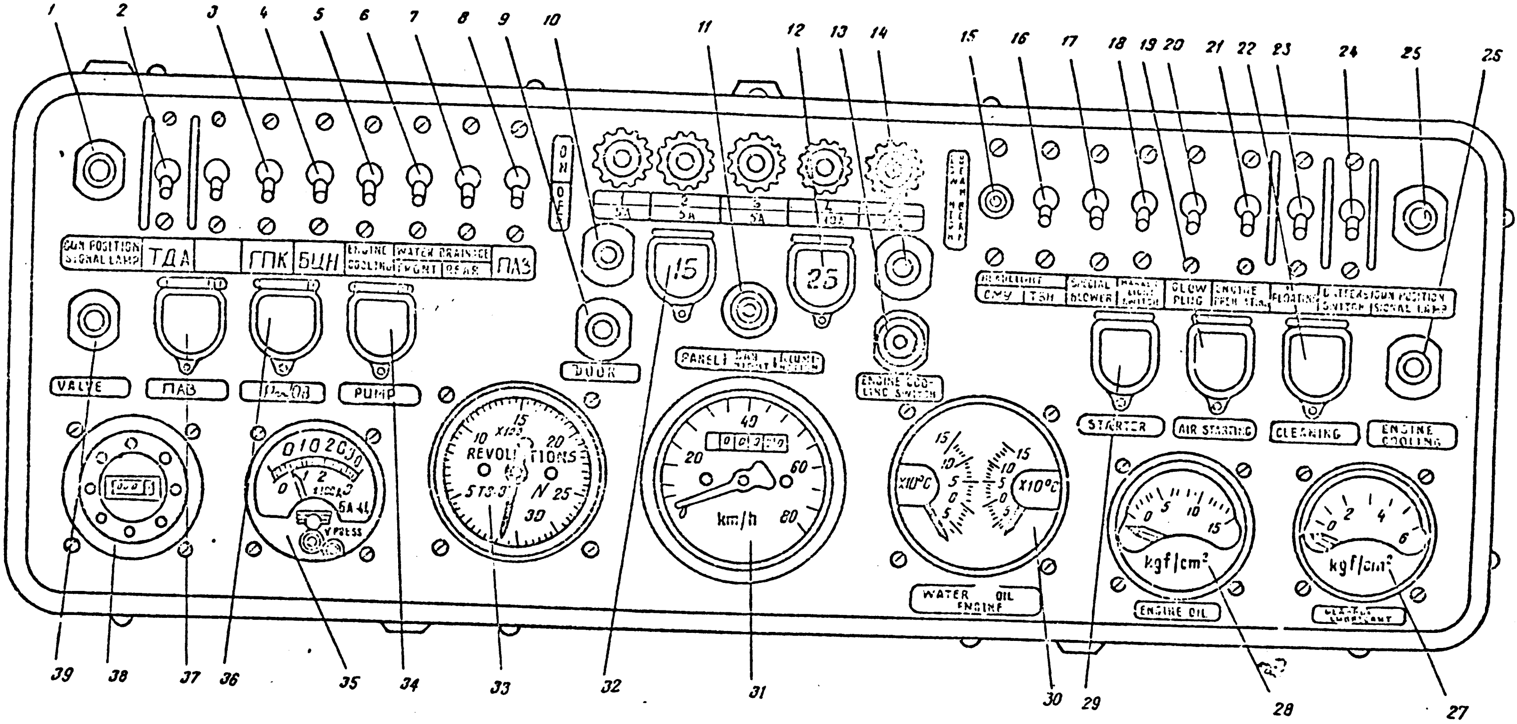
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25
GUN POSITION SIGNAL LAMP
ТДА
ГПК
БЦН
ENGINE COOLING
WATER DRAINAGE FRONT REAR
ПАЗ
ON OFF
DOOR
PANEL LIGHT
ENGINE COOLING SWITCH
GLOW PLUG
FLOATING
STARTER
AIR STARTING
CLEANING
ENGINE COOLING
VALVE
ПАВ
PUMP
15
25
REVOLUTIONS
km/h
X10°C
WATER OIL ENGINE
kgf/cm²
ENGINE OIL
39
38
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FIG.246. CENTRAL PANEL

1 - left-hand gun position signal lamp; 2 - smoke-generating system switch (ТДА); 3 - switch of gyro direction indicator; 4 - switch of fuel feed pump БЦН; 5 - switch to deenergize electric motor of engine cooling system preheater at sudden stop; 6 - switch of front water drainage pump; 7 - switch of rear water drainage pump; 8 - switch of atomic protection system (ПАЗ); 9 - rear door position signal lamp; 10 - signal lamp to indicate state of circuit of first cylinder of fire-fighting equipment; 11 - central panel illumination switch; 12 - cap of fire-fighting equipment cylinder button; 13 - button to switch off preheater water pump; 14 - signal lamp to indicate state of circuit of second cylinder of fire-fighting equipment; 15 - switch of left-hand headlight ФГ-127; 16 - switch of right-hand headlight ФГ-125 of vision device ТВН; 17 - special blower switch; 18 - marker light switch; 19 - cap of engine air starting button; 20 - preheater glow plug switch; 21 - preheater motor switch; 22 - cap of vision device air-and-liquid cleaning control button; 23 - engine protection valve switch; 24 - battery switch; 25 - right-hand gun position signal lamp; 25 - preheater water pump signal lamp; 27 - pressure gauge of power transmission lubricating system; 28 - pressure gauge of engine lubricating system; 29 - starter button cap; 30 - temperature gauge of engine lubricating and cooling systems; 31 - electric speedometer; 32 - cap of fire-fighting equipment second cylinder button; 33 - tachometer; 34 - cap of button of oil priming pump МЗН-2; 35 - voltammeter; 36 - cap of radiological and chemical protection system button; 37 - cap of atomic protection system button; 38 - hourmeter; 39 - engine protection valve signal lamp

[redacted]

The marker lights employ 28-V, 10-W bulbs.

The marker lights are turned on by MARKER LIGHT switch arranged on the central panel.

The internal lighting devices include six dome lamps ПМВ-61 and three flap lamps КЛСТ-64 intended to illuminate the central panel. The lamps use 28-V, 10-W bulbs.

The lighting devices are turned on by the switches provided beside the devices.

The stand-by lighting devices serve for illuminating the vehicle in emergency cases when the work is done at night, with the battery contactor switched off. For this purpose, the minus terminal of the devices is connected to the minus terminal of the batteries.

The stand-by lighting devices include: dome lamp ПМВ-61 with a switch and two sockets ШР-51 for connecting the inspection lamp.

Dome lamp ПМВ-61 and one socket are installed in the driving compartment, and the other socket, in the troop compartment near the left-hand door.

Owing to two sockets, the inspection lamp may be used both inside and outside the vehicle.

The light signalling devices comprise seven signal lamps on the central panel (Fig.246) and a stop light mounted on the rear plate of the vehicle between the doors. The purpose of the signal lamps arranged on the central panel is the following:

Two signal lamps 1 and 25, ФРМ1-Б (white) GUN POSITION SIGNAL LAMP (ВЫХОД ЗА ГАБАРИТЫ) come on when the gun barrel is beyond the vehicle width (the left-hand or right-hand lamp comes on, respectively).

The sending unit of these lamps is built in the turret collector ring box; it consists of two contact segments with insulating inserts; a brush sliding over them is connected to the lamp circuit.

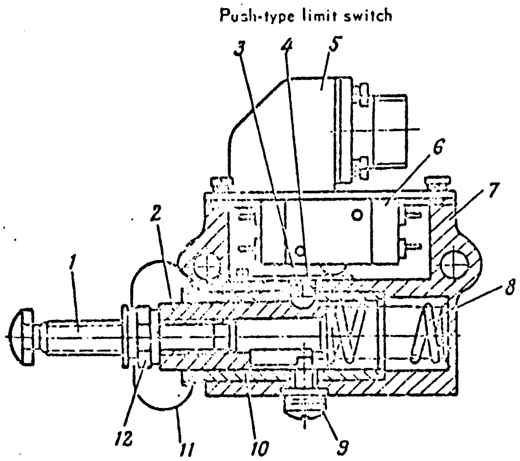

FIG.247. PUSH-TYPE LIMIT SWITCH

1 - screw; 2 - rod; 3 - ball; 4 - plate; 5 - plug connector; 6 - microswitch; 7 - limit switch body; 8 - return spring; 9 - locking screw; 10 - bushing; 11 - rubber boot; 12 - nut

Signal lamp 9, ФРМ1-К (red) DOOR (ДВЕРЬ) indicates that the rear doors are opened. Two push-type limit switches (Fig.247) mounted on brackets welded to the lateral rear beam of the roof serve as the sending unit of this lamp. As the doors are closed, the head of screw 1 turned into switch rod 2 is pressed by the door stop; as a result, the rod is displaced, and spring 8 is compressed by it. While moving, rod 2 raises ball 3 which actuates the ball of microswitch 6 through plate 4, thus opening the circuit of signal lamp 9 (Fig.246). When the door opens, the rod is pushed by the spring to the initial position, and the microswitch closes the circuit. The signal lamp lights up.

Two signal lamps 10 and 14 ФРМ1-К (red), serve to indicate serviceability of the electric circuits of the fire-fighting equipment. Connected to the circuits of signal lamps 10 and 14 are the squibs of the cylinders of the fire-fighting equipment. As the squib operates, the signal lamp goes out.

Signal lamp 26 ФРМ1-С (blue) ENGINE COOLING (ОХЛАЖДЕНИЕ ДВИГАТЕЛЯ) serves to indicate operation of the preheater water pump, and consequently circulation of the coolant through the cooling system of the engine.

Signal lamp 39 ФРМ1-С (blue) VALVE (КЛАПАН) serves to indicate closed position of the engine protection valves after the engine stalls during water obstacle crossing. The push-type limit switch secured on the lateral beam in the engine compartment serves as the sending unit of the signal lamp. As to its design, the switch is similar to that indicated in Fig.247.

[redacted]

[redacted]

and the valves close, lever 10 (Fig.194) of the limit switches presses the bolt of the rod of microswitch 30 and closes the signal lamp circuit.

Signal light panel RELEASE HAND BRAKE (ОТПУСТИ РУЧНОЙ ТОРМОЗ) is located under the central panel. This panel warns that the driver must release the hand brake when starting. The signal light panel is illuminated with three lamps 26 V, 0.12 W.

A push-type limit switch secured on the body of retainer 9 (Fig.205) of the parking brake control shaft (rack) is a sending unit of the signal light panel.

Signal lamps ОЛСТ-37 CLOSE HATCHES (ЗАКРОЙ ЛЮКИ) (28-V, 10-W bulbs) warn that the hatches are opened. One signal lamp is located on the bracket to the left of the driver, and the other, in the troop compartment.

The sending unit of the commander's hatch singal lamp is secured on the hatch cover beside the lock handle, and the sending unit of the driver's signal lamp is arranged on the driving compartment roof to the right of the driver. The sending units are push-type limit switches (Fig.247).

Red signal lamp 6 (Fig.250) ОЛСТ-37 indicates that supply voltage is fed to the loading mechanism control circuit.

Signal lamp 5 (МЗ) is located on the upper part of the signal board. The sending unit of the signal lamp is a limit switch.

Green signal lamp ЛСТ-37 indicates the readiness of the electrical equipment of the loading mechanism for operation.

It is located on the lower part of the signal board.

Signal lamp ОЛСТП-37 ФВТ VALVE OPEN (ОТКР. КЛАПАН ФВТ) is located on a bracket to the left of the driver. The sending unit of the lamp is a limit switch mounted on the branch pipe of valve box 1 (Fig.286) of the filter-ventilating unit.

Stop light is located on the rear plate of the vehicle between the doors. It is intended to warn that the vehicle is started. It serves also to cut in the circuit of the stopping brake pneumatic control system. The sending unit of the stop light is push-type limit switch 31 (Fig.205) mounted under the stopping brake control lever. When the brake pedal is depressed, the stop light comes on.

The stop light is similar in design to marker light ГСТ-64.

Electric horn C-58 is a sealed vibration-type electric horn actuated by the button on the steering column. The horn is mounted in the driving compartment on the sloping front plate to the left of the driver.

The horn consists of body 8 (Fig.248), electromagnet 9 with Ш-shaped core 14, breaker 7 and armature 2 with diaphragm 3. The breaker is mounted on a bracket whose one end is attached to the body, and the other end holds a screwed-in bolt fitted with a spiral spring. When in inoperative position, the breaker contacts are opened.

Capacitor 15 connected in parallel with the contacts serves to minimize their sparking and burning.

Armature 2 is assembled of the electrical steel sheets. It is fastened to diaphragm 3 and resonator 4 by means of central stem 16 and two nuts 1.

Diaphragm 3 is pressed to body 8 by rim 5 and secured with screws. The horn is connected to the electric circuit through two terminals 10.

When the button is pressed, the mains voltage is delivered through winding 13 and closed contacts of breaker 7 to the body. Under the action of the electromagnetic field, armature 2 is attached to Ш-shaped core 14, thus opening contacts of breaker 7. The supply circuit of the winding is broken, plate spring 12 makes armature 2 return to the initial position and lower the movable contact; under the action on the spring, the contact closes the circuit again. The current passes again (while the horn button is kept pressed), and the entire procedure is repeated. As a result, the armature vibrates together with the diaphragm and the latter produces a sound.

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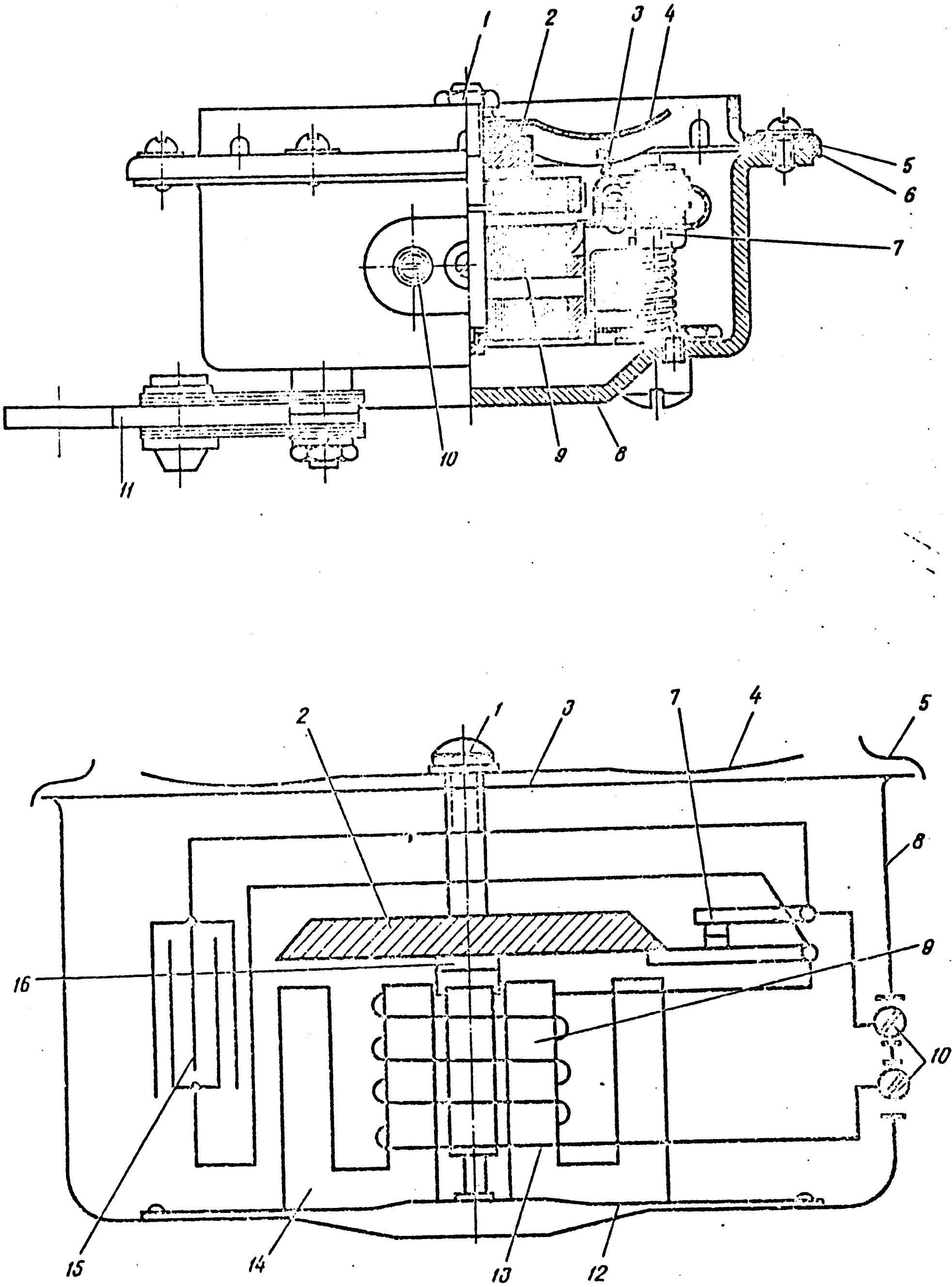
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FIG.248. ELECTRIC HORN C-58

1 - nut; 2 - armature; 3 - diaphragm; 4 - resonator; 5 - rim; 6 - gasket; 7 - breaker; 8 - horn body; 9 - electromagnet; 10 - terminals; 11 - bracket; 12 - plate spring; 13 - electromagnet winding; 14 - core; 15 - capacitor; 16 - stem

[redacted]

of the breaker screw which is brought outside.

9.3.5. Auxiliary Instruments

The central panel (Fig.246) is arranged in front of the driving compartment. It represents a metal panel secured on five brackets through shock absorbers.

The panel mounts instruments, circuit breakers, switches, buttons and signal lamps. For the arrangement and purpose of the instruments, see Fig.246.

The design of some instruments is described below.

The panel has seven safety fuses secured in their holders. The purpose of the safety fuses is shown on the diagram of the electrical equipment (Fig.226).

Provided on the back side of the panel are eight plugs 2PM to receive receptacles, two contactors КМ-50ДВ to remotely switch on the oil priming pump and preheater plug, 51-ohm resistor ПЭРВ-30 included in the headlight blackout circuit and 22-ohm resistor ПЭРВ-5 included in the panel blackout circuit.

The power board (Fig.249) serves to distribute the electric power among the consumers. It is secured on a bracket with four bolts over the storage batteries on the left-hand side.

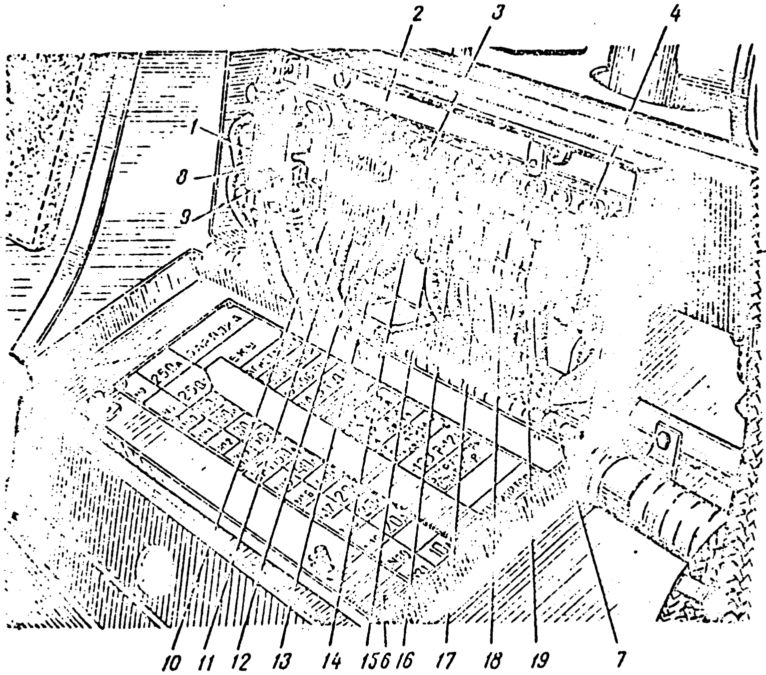

FIG.249. POWER BOARD

1 - voltammeter shunt; 2 - panel; 3 - bus-bar; 4 - protection units; 5 - terminal; 6 - cover; 7 - cover hinge; 8 - 250A safety fuse in battery circuit; 9 - 250A safety fuse in circuit of turret consumers; 10 - protection units for special blower and exhaust blower circuit; 11 - protection unit for TBH vision device headlight; 12 - protection unit for electric motor of oil priming pump МЗП-2; 13 - protection unit of relay box KP-40; 14 - protection unit of relay box KP-65; 15 - protection unit of heating system of right-hand troopers' vision devices; 16 - protection unit of heating system of left-hand troopers' vision devices; 17 - protection unit of commander's hatch collector ring box; 18 - protection unit of interphone system; 19 - protection unit of driver's vision devices heating system

The power board carries twelve protection units БЗ, shunt 1 of voltammeter BA-440, panel 2 with two 250-A safety fuses included in the battery charging circuit and turret consumers supply circuit.

The board is closed with cover 6 turning on horizontal hinges 7.

A plate attached to the inside of the cover indicates the purpose of the protection units.

The turret board (Fig.115) is mounted in the turret bay (Fig.250) to the left of the operator. It represents a metal box closed with a cover. Provided inside the board are six fuses:

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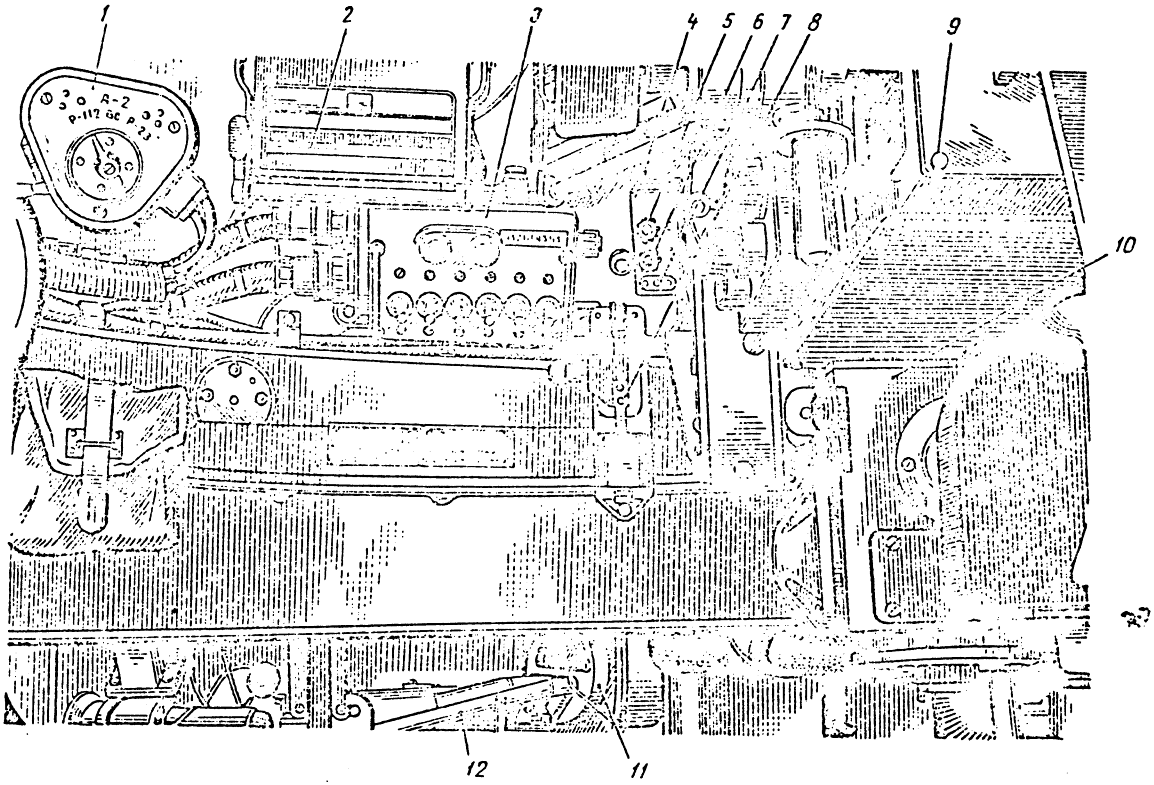

FIG.250. SIGNAL BOARD ARRANGEMENT

1 - control box ТПУ; 2 - operator's side vision device; 3 - turret board; 4 - signal board; 5 - signal lamp to indicate engagement of loading mechanism M3; 6 - signal lamp DRIVE to indicate loading mechanism readiness for operation; 7 - socket to connect test equipment; 8 - duplicating generator of electric trigger mechanism; 9 - sight; 10 - gun laying control panel; 11 - firing port; 12 - machine gun bracket

[redacted]

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- 5 A fuse - in the machine gun electric trigger circuit;
- 2 A fuse - in the loading mechanism electrical equipment circuit;
- 20 A fuse - in the 1ЭЦ10М elevation drive;
- 5 A fuse - in the turret lighting circuit;
- 2 A fuse - in the circuit of signal lamps CLOSE HATCHES.

The front panel of the board mounts:

- buttons and switches whose purpose is shown on the panel;
- signal board of the turret (Fig.250) is located in front of turret board 3. It is essentially a metal box closed with a cover;
- two signal lamps 5 and 6 of the loading mechanism.
- socket 7 provided on the lower part of the panel serves to connect the test equipment;
- vision device cleaning control panel 38 (Fig.127) is arranged to the left of the commander under the radio station. It represents a box having button CLEANING (ОЧИСТКА) and a socket for connection of an external power source. This button serves to switch on the electropneumatic valve of the air-and-liquid cleaning system.

Relay box 6 (Fig.7) КР-40 is included in the electric circuit of the automatic protection system and fire-fighting equipment. It is installed in the driving compartment on the front lower plate of the hull.

The relay box accommodates relays and contactors of the common switching equipment:

- atomic protection relay (РАЗ);
- radiological and chemical protection relay (РРОВ);
- front compartment contactor (КПО);
- relay РПР ensuring semi-automatic operation of the fire-fighting equipment;
- relay Р1Б of the first cylinder of the fire-fighting equipment;
- relay Р2Б of the second cylinder of the fire-fighting equipment;
- engine protection valve relay РКД.

Relay box КР-65 is designed to automatically start electric motor МБП-3Н of the preheater pump unit when the engine is stopped. For the description of the relay box, see Subsection 6.6.3.

Relay boxes КР-60 and КР-55 are used in the vision device heating system.

One box КР-60 is installed in the bay of the troop compartment (Fig.251), and two boxes КР-55 are mounted in the rear section of the troop compartment at the side walls of the hull.

For the description of the relay boxes, see Subsection 5.7.2.

9.3.6. Instruments

Hourmeter 38 (Fig.246), type 563-ЧП-М, is designed to automatically record the time of engine operation. The operating principle is based on registration of the generator operation time which is the same as the engine operation time.

The hourmeter consists of clockwork 4 (Fig.252), electric winder, starting and stopping devices and counting mechanism 5.

Clockwork 4 includes a train of interacting gear wheels, escapement 19 and regulator 18. The train of gear wheels transmits the movement from traction spring 6 (driving element) to regulator 18.

The pallet-type escapement system periodically releases the gear train and imparts pulses to the regulator.

It transforms the rotary motion of the gear train into the oscillatory motion of regulator 18.

Regulator 18 is a spiral spring (hair) connected with balance 3 arranged on a wheel. The period of regulator oscillations is T=0.4 s.

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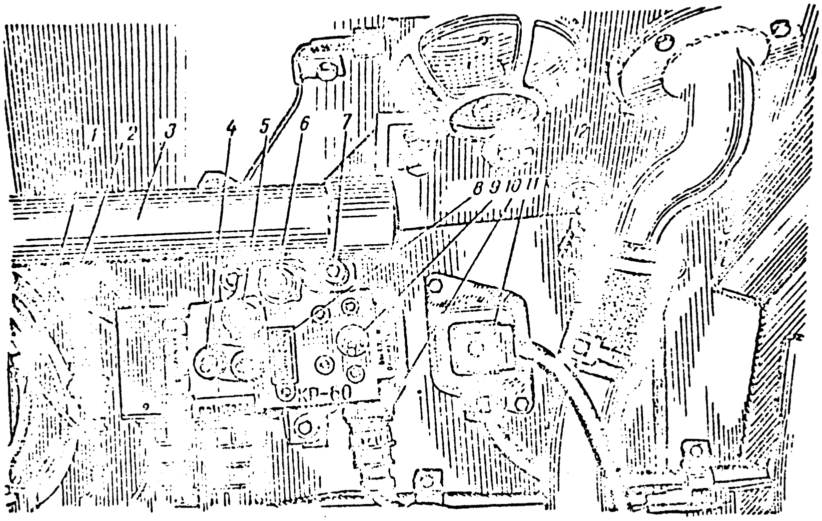

FIG. 251. INSTALLATION OF RELAY BOX KP-60 IN BAY OF TROOP COMPARTMENT

1 - ball mount of ПК machine gun; 2 - powder gas suction hose; 3 - gas line of ventilation system; 4 - ТНПО-170 vision device heater switch; 5 - heater signal lamp; 6 - signal lamp; 7 - box securing bolt; 8 - ТНПО-170 vision device heater change-over switch; 9 - firing port glass heater switch; 10 - plug connector; 11 - control box of interphone system; 12 - dome lamp

Balance 3 is secured on an axle resting on jewels.

The electric winder is designed for periodically winding the clockwork. It includes
winder spring 7, electromagnet coil 10, armature 9 and interrupter with contacts 11.

The hourmeter operates as follows.'

When the engine is inoperative and the battery switch is in the OFF position, and
traction spring 6 is not wound, the armature of the electromagnet keeps contacts 11 and 20
closed through pin 14. As soon as the battery contactor is switched on, the current flows fr
terminal Б (Fig.253) to the body through the winding of electromagnet coil 10 (Fig.252),
contacts 11 and 20 and lever 13.

Armature 9 turns under the action of the .electromagnetic field and winds (extends)
traction spring 6 and simultaneously turns lever 13 (Fig.253) and opens contacts 11 and 20
(thus opening the battery circuit) by its pin 14 (Fig.252). In this position spring 6 canno
turn armature 9 since it is connected with the clockwork which is locked with pin 22 (Fig.2
of locking lever 2 (Fig.252), and the hourmeter is inoperative.

As soon as the engine is started, the generator is put into operation. The current
flows from generator 24 (Fig.253) to the body across contact Г through the winding of
electromagnet 1. Under the action of the electromagnetic field, armature 21 (Fig.252) is
attracted, and pin 22 (Fig.253) is uncoupled from balance 3 (Fig.252). As a result, the pi
turns the balance energetically, thus providing a reliable starting pulse.

Traction spring 6 makes armature 9 turn together with ratchet wheel 15. The gear trai
and the clockwork are put into operation, the hourmeter starts counting the time of the
engine operaion. As soon as the engine stops, the winding of electromagnet 1 is deenergize
armature 21 moves away from the core, and pin 22 (Fig.253) stops balance 3 (Fig.252) and c
sequently, the clockwork under the action of lever 2 (plate spring). Now, the hourmeter at

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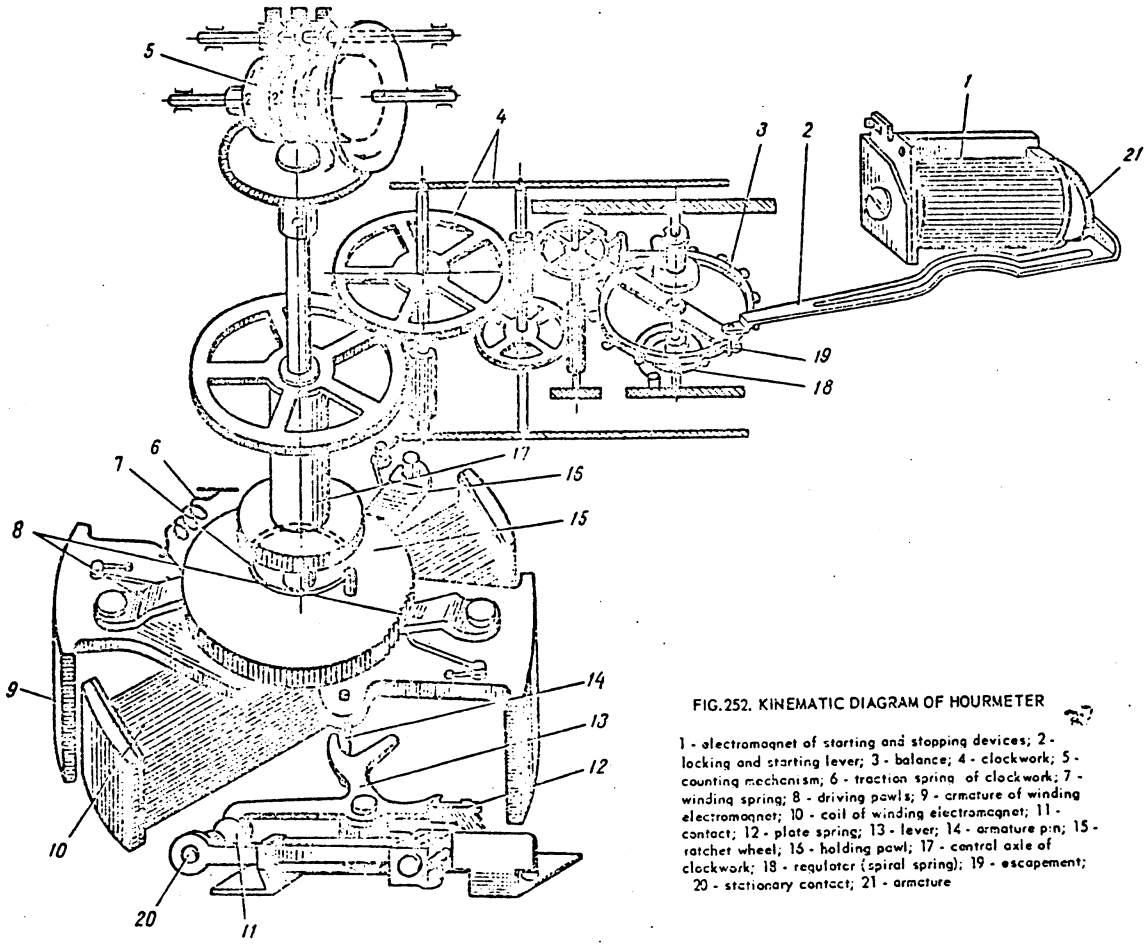

FIG. 252. KINEMATIC DIAGRAM OF HOURMETER

1 - electromagnet of starting and stopping devices; 2 - locking and starting lever; 3 - balance; 4 - clockwork; 5 - counting mechanism; 6 - traction spring of clockwork; 7 - winding spring; 8 - driving pawls; 9 - armature of winding electromagnet; 10 - coil of winding electromagnet; 11 - contact; 12 - plate spring; 13 - lever; 14 - armature pin; 15 - ratchet wheel; 16 - holding pawl; 17 - central axle of clockwork; 18 - regulator (spiral spring); 19 - escapement; 20 - stationary contact; 21 - armature

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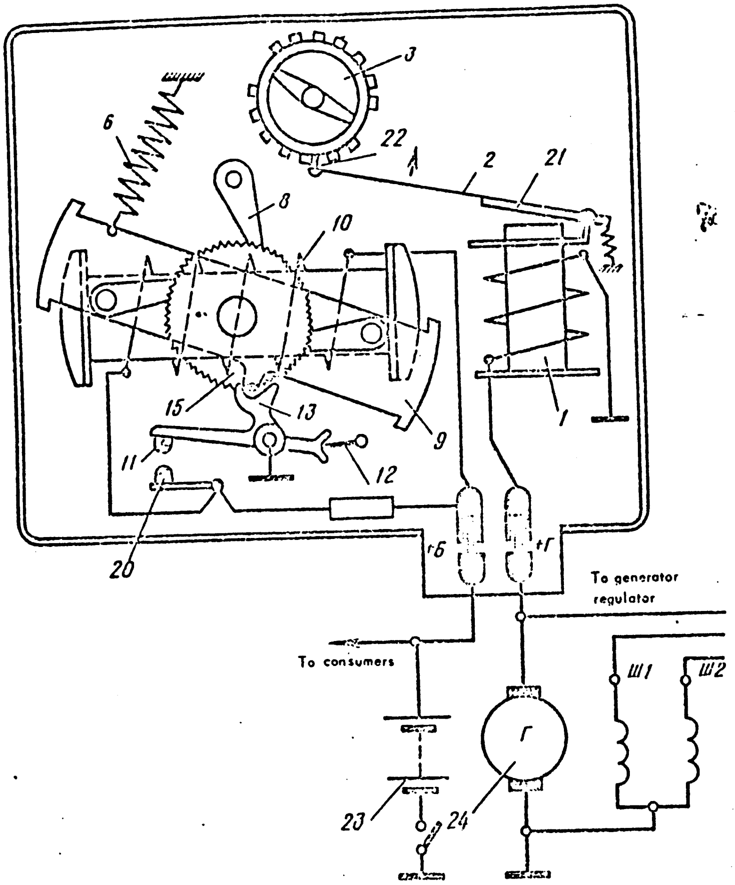

FIG.253. OPERATIONAL DIAGRAM OF HOURMETER (REF. NOS SAME AS IN FIG.252)

22 - brake pin; 23 - storage batteries; 24 - generator

When spring 6 is fully unwound, i.e., when it turns armature 9 by the maximum angle, the armature turns lever 13 by the pin, and thus presses contact 11 to contact 20.

The battery circuit is closed, and the current, passing over the winding of electromagnet coil 10 induces an electromagnetic field which makes the armature turn, and thus wind the spring. So, the winding mechanism periodically winds the spring. The contacts close every 2 - 3 min. To prevent hourmeter stopping during spring winding, provision is made for an auxiliary spring. This spring actuates the clockwork during main spring winding.

The counting mechanism is similar to telephone counters. It records the time of the engine operation in tenth fractions of an hour, and in hours.

The right-hand drum indicates the tenth fractions of an hour, and the other drums, hours tens of hours and hundreds of hours.

Voltammeter BA-440 (Fig.254) is a combined moving-coil instrument designed for mesuring the mains voltage and charging current. If the ammeter pointer deflects to the right, the storage batteries are charged, and if to the left, discharged.

The voltammeter has a cylindrical body closed at one end with screen 2, and at the other end, with casing 11.

The body incorporates a moving-coil system consisting of light aluminum frame 21 with winding, spring holder and pointer 12 having tabs 26 with weights. The moving-coil system rests with its cores on corundum thrust bearings. Case 16 with the thrust bearing is screwed into

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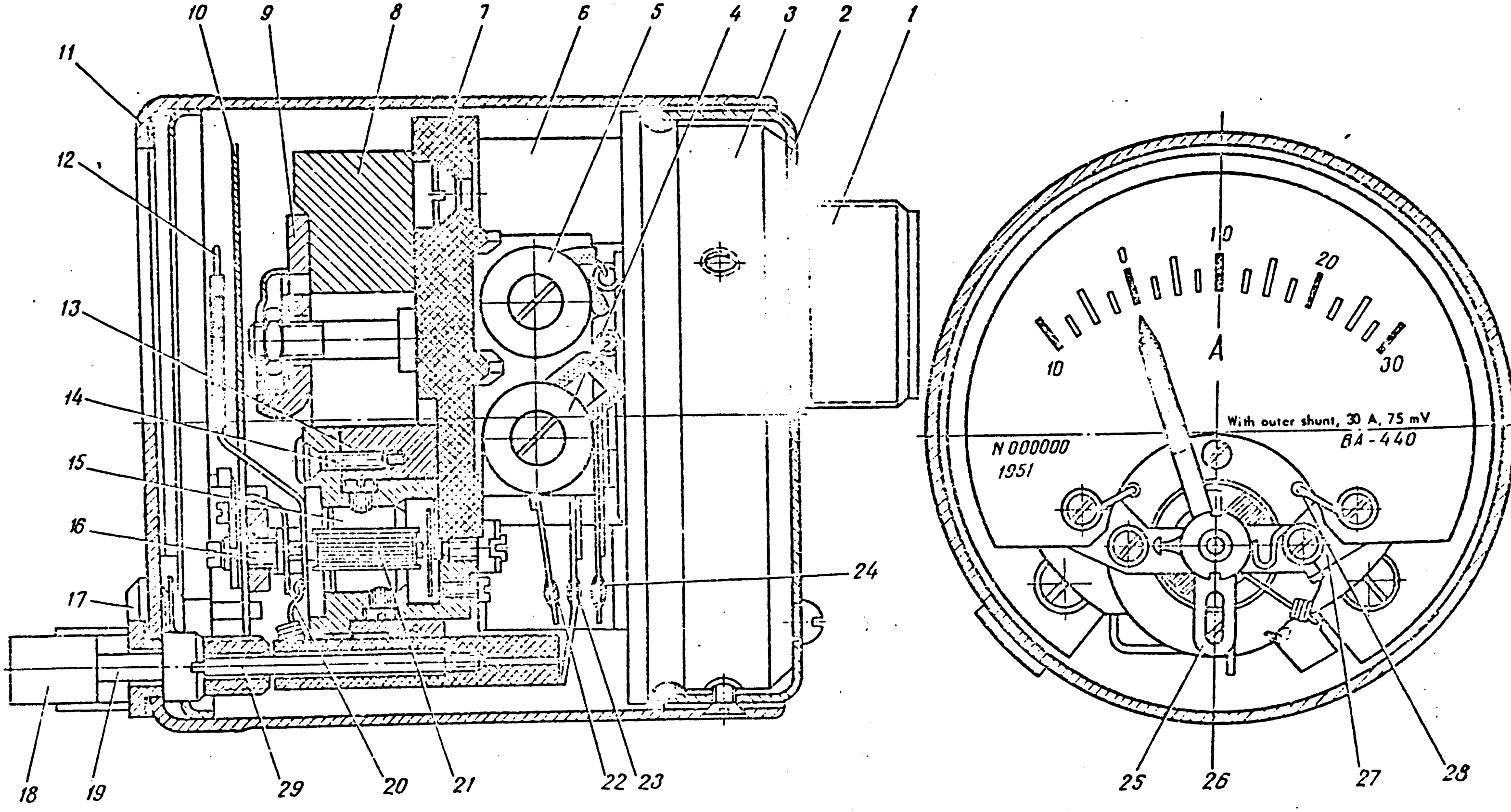
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ВА-440

FIG.254. VOLTAMMETER

1 - plug connector; 2 - screen; 3 - base; 4 - multiplier; 5 - compensating resistor; 6 - post; 7 - plate (disc); 8 - magnet; 9 - strap; 10 - scale; 11 - casing; 12 - pointer; 13 - core; 14 - screw; 15 - pole shoe; 16 - case with thrust bearing; 17 - adjuster screw; 18 - button; 19 - stem; 20 - spring; 21 - frame; 22, 23 and 24 - plates; 25 - adjuster; 26 - tab with weight; 27 - bridge; 28 - limiter; 29 - adjuster screw

[redacted]

the holder on one side, and into bridge 27 on the other side. The holder with the bridge, moving-coil system and core is secured in the slots of pole shoes 15 by means of screws. The stationary portion of the instrument consists of multiplier 4 and compensating resistor 5, magnet 8 secured with strap 9 to carbolite plate 7 and contact plates 22, 23 and 24.

The principle of voltammeter operation is based on interaction of fixed magnet 8 with the magnetic field of movable frame 21 when the current flows through it. As a result of interaction of the fields of the magnet and frame (Fig.255), the frame turns together with the pointer by an angle proportional to the current intensity. Only a low current (hundredths of an ampere) flows through the frame, while the larger portion of the current passes through the parallel-connected bus-bar (shunt) having a large cross-sectional area.

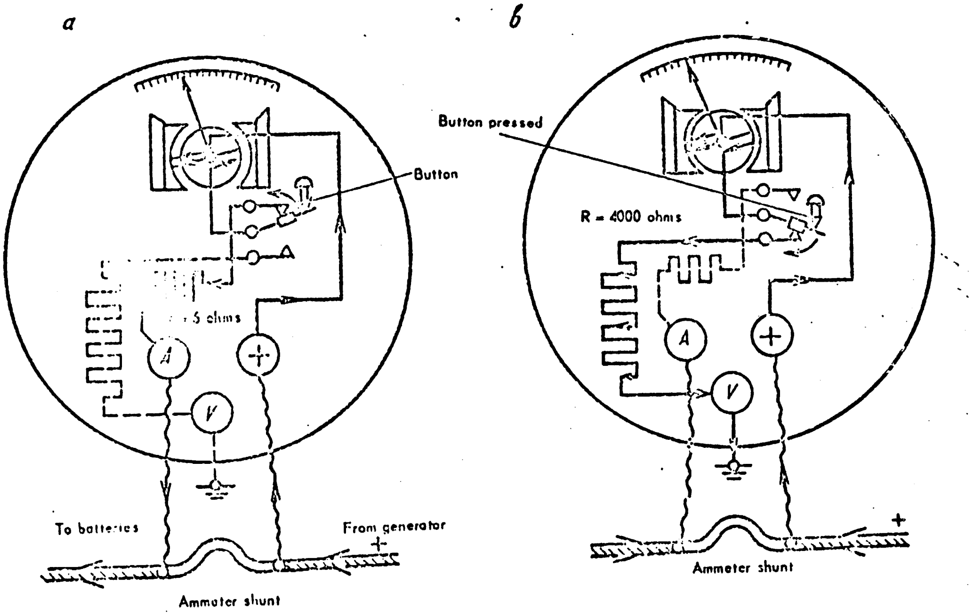

FIG.255. OPERATIONAL DIAGRAM OF VOLTAMMETER

a - voltammeter operation during measurement of charging current; b - voltammeter operation during voltage measurement

When the button is released, the voltammeter operates as an ammeter.

In this case, the mains current flows through the winding of the frame, upper closed contacts and 6-ohm resistor. Interaction of the fields causes the pointer deflection. If the batteries are discharged, the current in the frame is reversed, and the pointer deflects to the left.

When the button is pressed, the upper contacts open, and the lower contacts, close. The current passes through the 4000-ohm resistor and deflects the pointer by an angle proportional to the voltage.

The voltammeter is enclosed in a metal body whose face side bears two scales and button 18 (Fig.254). Located beside the button is the screw of the adjuster which is used to zero the pointer.

Electric tachometer TЭ-4 (Fig.256) indicates the speed of the engine crankshaft. The tachometer consists of generator 2 and single-pointer indicator 1. The speed measurement range is 0 to 4000 rpm.

[redacted]

[redacted]

energy of revolving generator rotor into electric energy proportional to the rotational speed of the rotor, and consequently, of the engine crankshaft.

The tachometer generator is a three-phase A.C. machine attached to the flange of the cylinder block-and-crankcase unit on the flywheel side. It is driven by the crankshaft through cluster gear 9 (Fig.146) of the accessory drive with which it is connected by means of a shaft.

The indicator is mounted on the central panel and connected with the generator through an electric cable.

The generator of instrument Д-4 is a three-phase generator. Rotor 8 (Fig.256) of the generator is a permanent magnet rigidly connected with shaft 21. Rotation of the crankshaft is transmitted to rotor 8 through the shank of drive shaft 22 which is joined with hollow shaft 21 of the generator.

Stator 7 of the generator has twelve slots holding a double-layer winding. The stator bars are insulated from each other.

The indicator consists of a synchronous three-phase electric motor and indicator mechanism. The winding of the indicator stator is similar to the generator winding.

The electric motor rotor consists of two cross-shaped magnets 39 freely fitted on rotor shaft 30 and auxiliary magnet 32 (having disc 31 made from non-magnetic metal) fitted on a separate bushing secured on the shaft with a cotter pin.

The bushing of cross-shaped magnets 39 is connected with shaft 30 with spiral 29 permitting the rotation of the bushing relative to the shaft by 360°.

Magnet assembly 43 secured on the end of the electric motor shaft consists of two plates holding pressed-in magnets 28; secured between the plates is axle 26 of sensing element 42 (disc). The axle carries damper disc 25 and indicator pointer 46.

The tachometer operates as follows (Fig.257).

With the engine running, generator rotor 2 revolves, and the magnetic flux of the latter crosses stationary windings 1 of the generator stator. Electromotive forces induced in the windings are shifted in phase by 120°. The frequency of the induced e.m.f. is proportional to the rotor speed.

As generator stator windings 1 are connected with electric motor stator windings 3, currents of the same frequency pass through the latter.

Owing to the three-phase current flowing in the electric motor coils inside the stator where rotor 4 is arranged, revolving magnetic flux of the stator is induced; the rotational speed of the latter is proportional to that of the motor shaft. The magnetic flux causes rotor 4 to revolve.

At the moment the electric motor is started, the rotor magnet cannot follow the revolving magnetic flux because of abrupt speed rise and inertia forces.

In this case, the magnetic flux is induced in metal disc 7 of the rotor whose currents interact with the revolving flux and cause rotor 4 to revolve.

As the rotational speed of the rotor becomes equal to that of the magnetic flux, disc 7 is not crossed by the magnetic flux, and no currents are induced in it.

With rotor 4 rotating, the magnetic flux of magnet assembly 6 crosses sensing element 7 and induces eddy currents in it; the intensity of the currents is proportional to the rotational speed of motor rotor 4, and, consequently, to that of the engine crankshaft.

As a result of interaction of eddy currents with the magnetic flux of magnet assembly 6, sensing element 7 is acted upon by a moment proportional to the speed of crankshaft rotation. The rotation moment is balanced by the moment of spring 8. Under the action of this moment sensing element 7 turns, together with pointer 11 of the indicator, by an angle proportional to the vehicle engine crankshaft speed of rotation.

A magnetic damper representing aluminum disc 9 fitted on an axle between the end faces of fixed magnets 10 serves to rapidly damp the oscillations of the moving-coil system (pointer).

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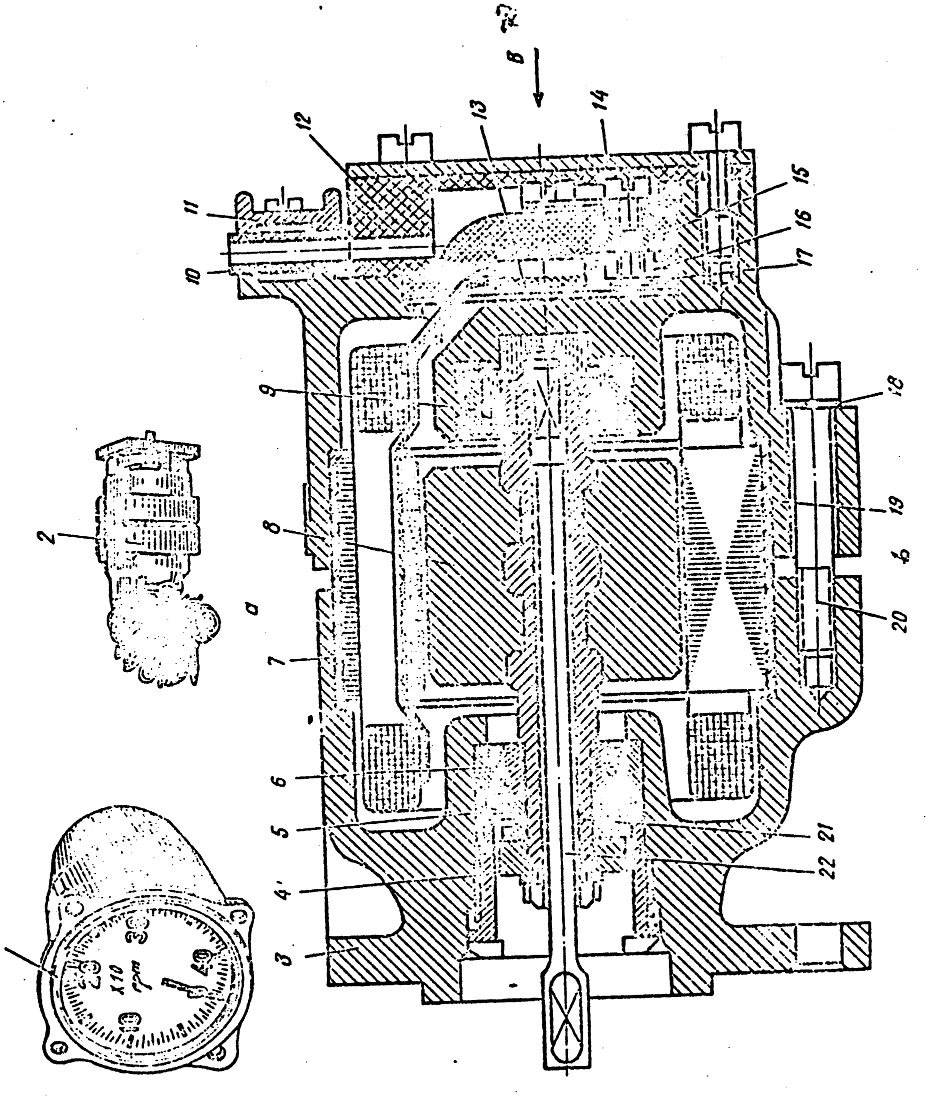

а
б
В
X10
rpm

[redacted]

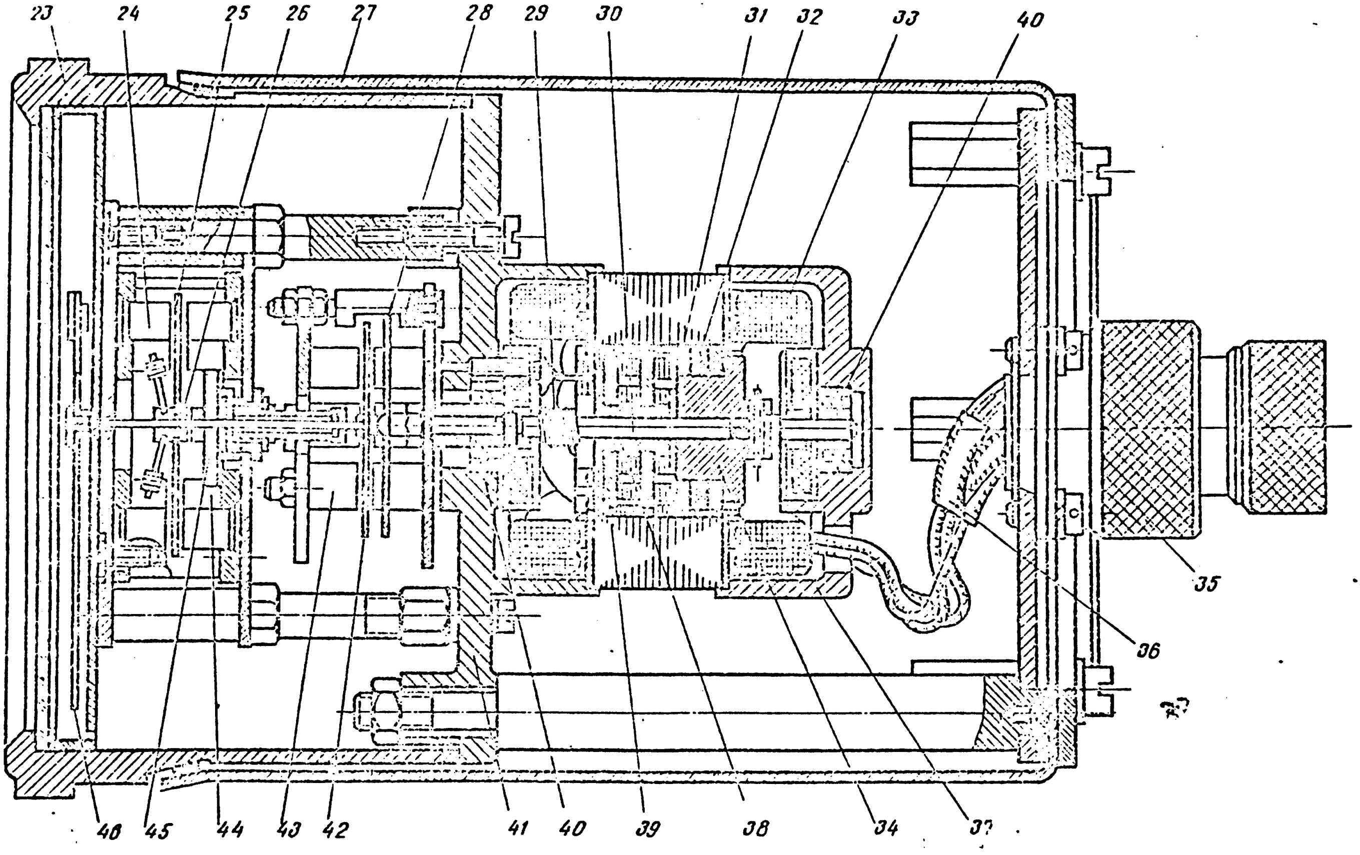

FIG. 256. ELECTRIC TACHOMETER T3-4

a - general view; b - sectional view of tachometer generator; c - sectional view of tachometer indicator; 1 - indicator; 2 - generator; 3 - front cover; 4 - threaded bushing; 5 - gland; 6 - ball bearing; 7, 33 - stators; 8, 23 - rotors; 9 - ball bearing; 10, 34 - bushings; 11 - collar; 12 and 13 - gaskets; 14, 37, 41 - covers; 15 - connector; 16 - washer; 17 - nut; 18 - spring washer; 19 - rear cover; 20 - screw; 21 - hollow shaft of tachometer generator; 22 - driving shaft; 23 - indicator housing; 24 - damper magnets; 25 - disc; 26 - axle of sensing element; 27 - casing; 28 - magnetic shunt; 29 - spring; 30 - rotor shaft; 31 - hysteresis disc; 32 - auxiliary magnet; 35 - plug connector; 36 - vinyl chloride tube; 39 - magnet; 40 - ball bearing; 42 - sensing element; 43 - magnet assembly; 44 - carrier; 45 - counteracting spring; 46 - pointer

[redacted]

[redacted]

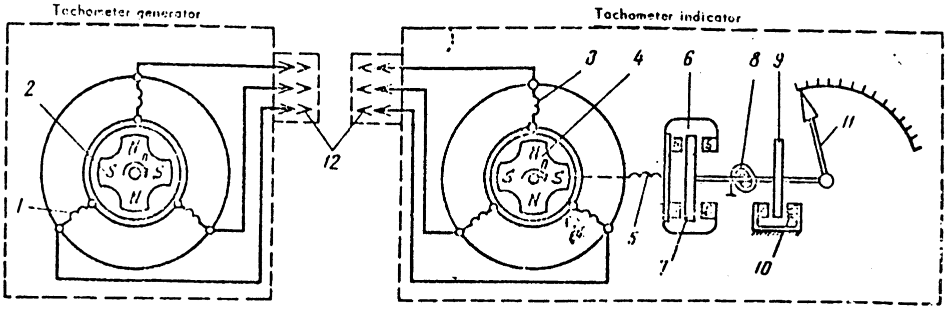

FIG.257. SCHEMATIC DIAGRAM OF TACHOMETER

1 - winding of tachometer generator stator; 2 - tachometer generator rotor; 3 - winding of tachometer indicator motor stator; 4 - rotor of tachometer indicator motor; 5 - spring; 6 - magnet assembly of tachometer indicator; 7 - sensing element (disc); 8 - counter-acting spring; 9 - damper disc; 10 - magnet assembly of damper; 11 - pointer; 12 - plug connector

As pointer 11 oscillates, the magnetic flux of damper magnet assembly 10 crosses an alum num disc and induces in it eddy currents; the latter interact with the magnetic flux of magnet assembly 10 and damp the moving-coil system.

Temperature gauge 2TVD-111 (Fig.258) serves for remote measurement of the engine o coolant temperature. It consists of two sending units 3 and one indicator 1 having two scales calibrated from 50 to 150°C.

Sending unit 3 of the temperature gauge is non-detachable. It consists of a tempera-ture-sensing element, fittings and plug connector. The temperature-sensing element compri nickel wire 11 wound on mica plate 12 and series-connected to manganin spiral 9. Laid at both sides of the temperature-sensing element are mica insulating spacers 6 covered with copper silver-plated spring plates 4 which ensure reliable heat transfer from the heat carrier to the temperature-sensing element. The temperature-sensing element assembly is inserted in the stainless-steel tube (fitting 5) and secured with a nut.

The sending unit is connected with the indicator through plug connector 8 and electr wires.

The oil temperature sending unit is screwed into the pipe union of the oil line running from the oil pump to the oil coolers.

The coolant temperature sending unit is mounted in the pipeline through which the coolant is discharged from the cylinder block-and-crankcase unit.

The temperature indicator consists of two similar logometer systems connected to the bridge circuit of the instrument.

The basic component of the logometer system is a logometer. The latter consists of two pairs of fixed rectangular coils (frames) 5 and 6 (Fig.259) positioned at an angle of 120° to each other, and movable flat magnet 3 made from an alloy of iron, nickel and alumin The magnet is secured inside the coils on axle 4 whose end carries pointer 8.

The movable magnet is surrounded by damper 2 which acts in the same manner as the tachometer indicator damper.

The bridge circuit of the indicator (Fig.258) consists of a set of resistance coils, logometer windings r_1 and r_2 and sending unit spiral $R_{s.u.}$ (Fig.236).

The operating principle of the temperature gauge is the following: changes in the temperature cause changes in the resistance of the sensing element of sending unit ($R_{s.u.}$), a result, the intensity and ratio of the currents in frames r_1 and r_2 of the indicator brid circuit are changed.

Changes in the temperature are taken up by the sensing element of the sending unit an fixed by the moving-coil logometer of the indicator. The operating principle of the logomet

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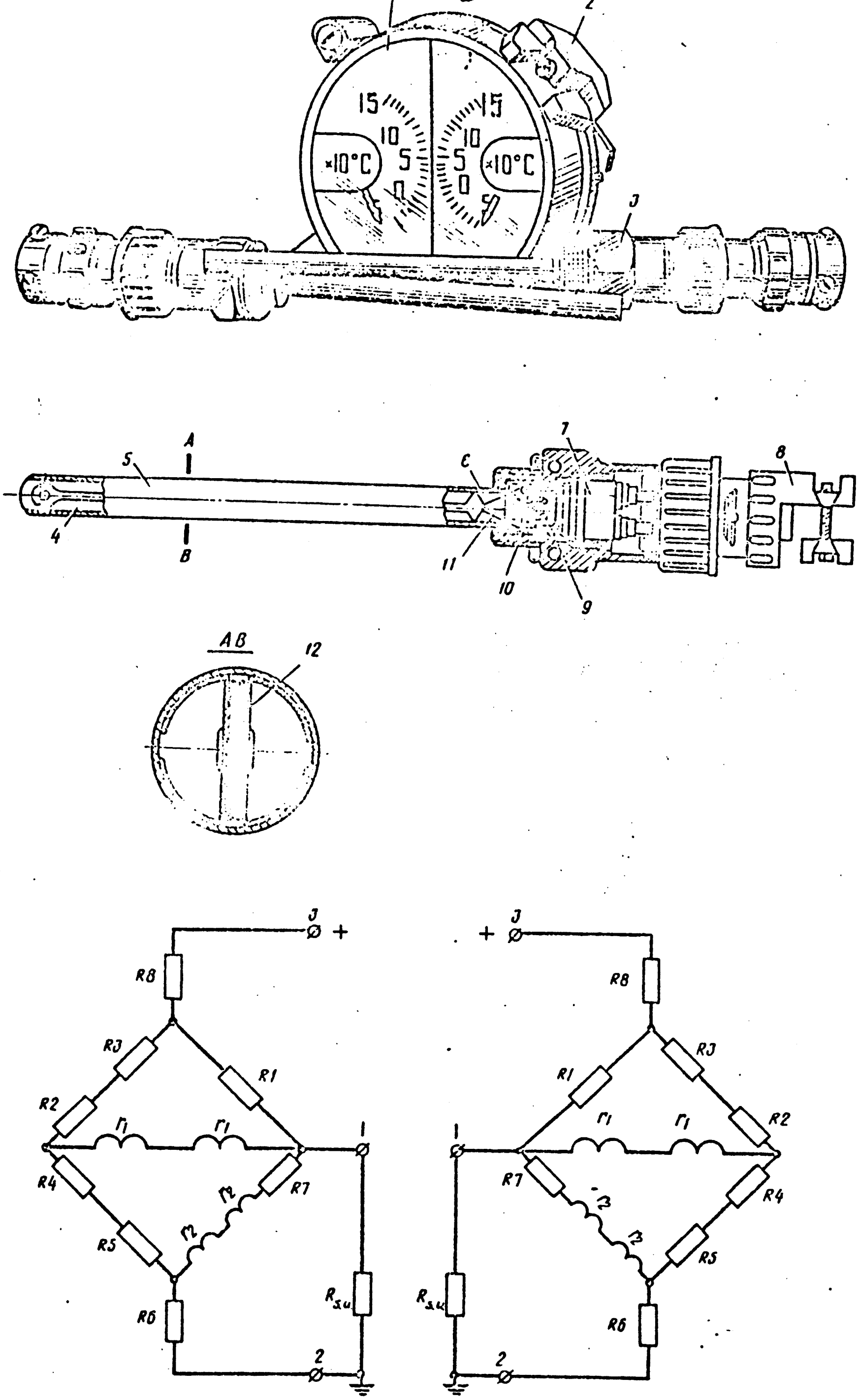
1
2
15
10
5
0
×10°C
15
10
5
0
×10°C
3
A
5
6
7
8
4
B
11
10
9
AB
12
3
+
R8
R3
R1
R2
r1
r1
1
R4
R7
r2
r2
R5
R6
Rs.u
2
+
3
R8
R1
R3
r1
r1
R2
1
R7
R4
r3
r3
R5
Rs.u
R6
2

FIG.258. TEMPERATURE GAUGE 2TY1-III

1 - indicator; 2 - fastening ring; 3 - sending units; 4 - heat transfer plate; 5 - fittings; 6 - mica spacer; 7 - receptacle; 8 - plug connector; 9 - manganin spiral; 10 - post lug; 11 - nickel wire; 12 - mica plates

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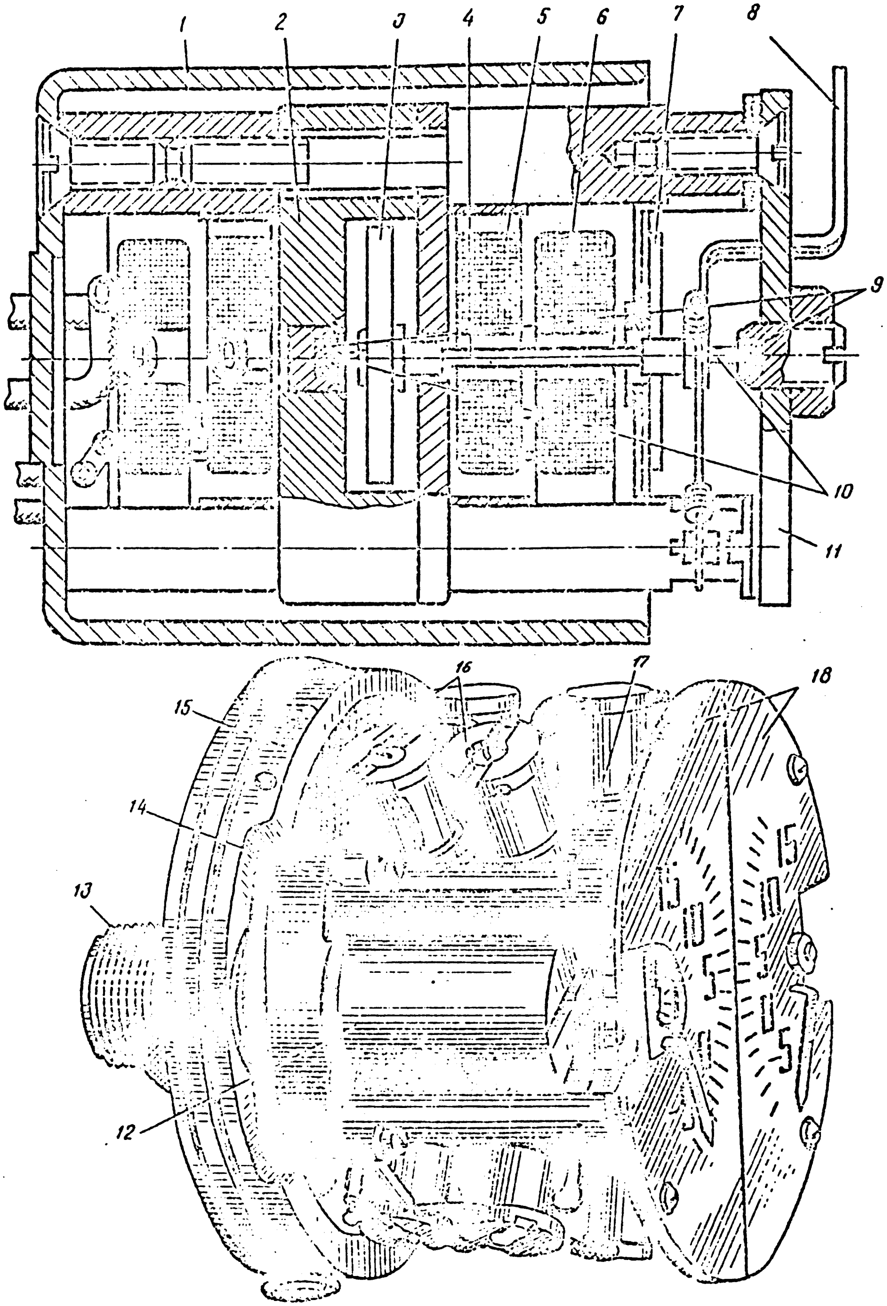
1
2
3
4
5
6
7
8
9
10
11
16
17
18
15
14
13
12

FIG.259. LOGOMETER AND INDICATOR OF TEMPERATURE GAUGE

1 - screen; 2 - damper; 3 - movable magnet; 4 - axle; 5 - inner frame; 6 - outer frame; 7 - permanent magnet; 8 - pointer; 9 - thrust bearing; 10 - cores; 11 - bridge; 12 - logometer; 13 - plug connector; 14 - plug connector; 15 - base; 16 - resistance coils; 17 - panel; 18 - scales

[redacted]

frames is energized, the movable magnet is oriented by the field of this frame. If both windings are energized, the magnet position is determined by the vector of the resultant field of both frames.

The fields of outer frames r_1 cause the movable magnet to turn towards the beginning of the scale, and the fields of inner frames r_2 cause the magnet to turn to the end of the scale.

The permanent movable magnet whose axle carries the indicator pointer, turns under the action of the resultant magnetic field of the frames and deflects the pointer by an angle depending on the ratio of the frame currents and, consequently, on the temperature under measurement.

Pressure gauge ТЭМ-15 (Fig.260) serves for remote measurement of the oil pressure in the engine lubricating system. The pressure gauge set includes sending unit 2, indicator 3, flexible hose 5 and fastening ring 4.

The sending unit consists of an aluminum body having corrugated diaphragm 6 hermetically sealed in the latter, rheostat 10 and transmission mechanism. The sending unit is screwed with its pipe union 7 into the threaded hole between the cylinder blocks, which communicates with the oil main line.

From the oil main line oil passes through the pipe union and fills space "a" under the diaphragm.

When the pressure rises, the diaphragm deflects and pushes rod 18 which presses the arm of rectangular rocking lever 13. Rocking lever 13 turns and shifts carrier 14 by its arm. The guide carrying brush holder 12, turns about axle 16 and displaces movable contact (wiper) 9 over rheostat 10. With the pressure decreasing the wiper moves back under the action of spring 17 whose end is secured on carrier 14.

The ends of the rheostat and the housing holder are connected with the contacts of the plug connector with electric wires.

The pressure gauge indicator (Fig.261) consists of cylindrical housing 7, plastic base 13, logometer, resistance coils 9, dial 8 and pointer 3.

The basic component of the indicator is a logometer which is secured on a plastic base.

The front portion of the base mounts four resistors. The resistors and frames I and II of the logometer are connected as shown in the diagram.

The pressure gauge functions as follows:

With the pressure varying, the sending unit diaphragm displaces wiper C over the rheostat, thus changing the ratio of the resistance of section a-c to that of section b-c.

A certain value of the measured pressure corresponds to a certain resistance of sections a-c and b-c. The ratio is measured by the logometer whose design and operation are described above. Rheostat sections a-c and b-c form two variable arms of the bridge, and two other arms R1 and R2 are permanent.

When the power supply source (mains) is connected to the bridge diagonal, currents flow in frames I and II of the logometer; the ratio of the currents depends on the ratio of arms a-c and b-c, i.e. on the value of the pressure under measurement. If the pressure is equal to zero, the maximum current flows in frame I, there is no current in frame II, and the magnetic field is generated by frame I only. In this case, movable magnet M of the logometer is positioned along the frame axis, and the pointer settles against "0".

With the pressure rising, the wiper of the sending unit approaches point "b" of the rheostat, and the current in frame I decreases, and in frame II, increases. The vector of the resultant flux of the magnetic fields of the frames is reversed, and movable magnet M turns in the direction of a greater pressure.

When the power is cut off, the pointer returns to the zero reading under the action of auxiliary fixed magnet ДМ.

[redacted]

[redacted]

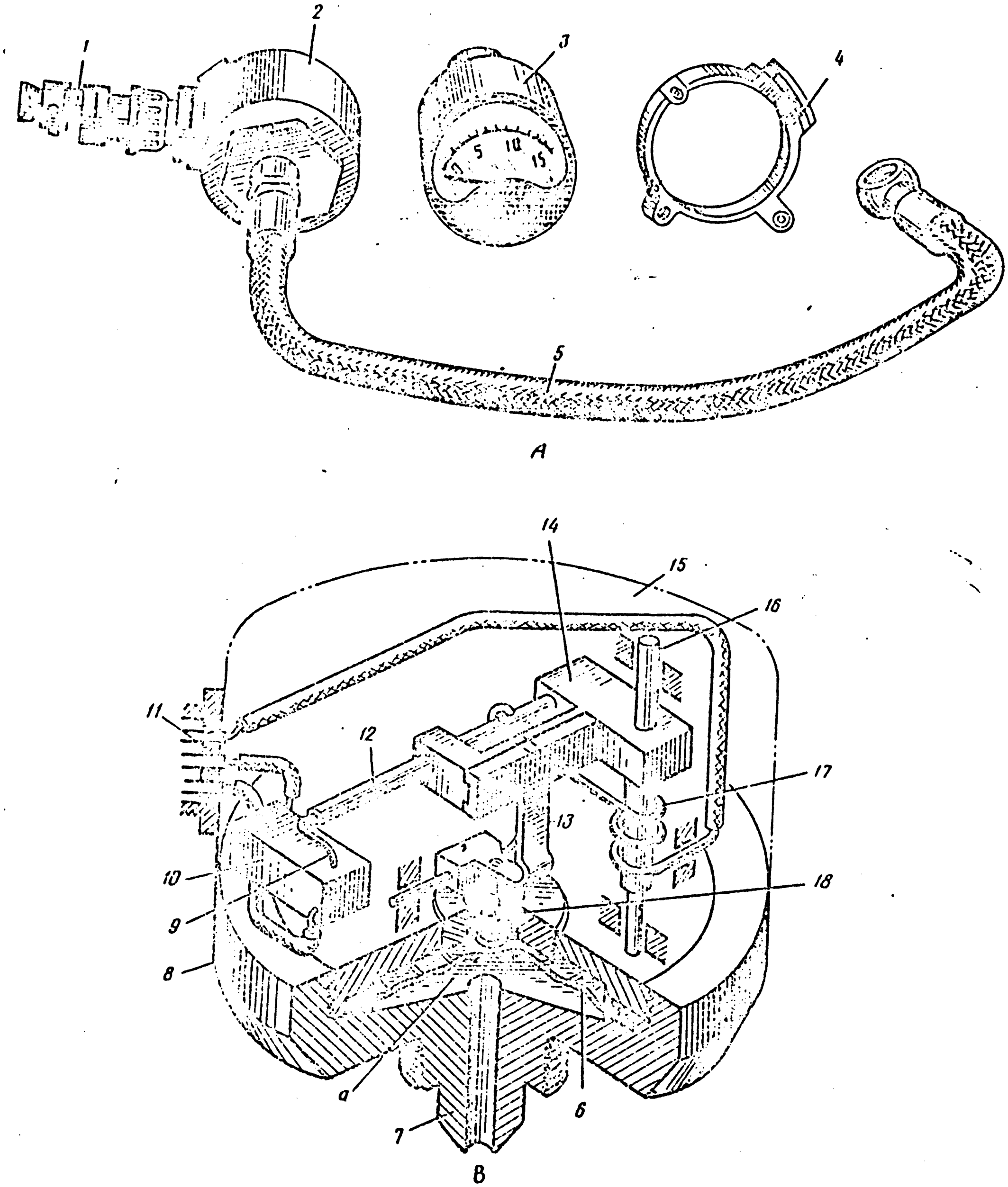
1
2
3
4
5
5
10
15
A
14
15
16
11
12
17
13
10
18
9
8
a
6
7
B

FIG. 260. PRESSURE GAUGE TЭM-15

A - set; B - sending unit

1 - plug connector; 2 - sending unit; 3 - indicator; 4 - fastening ring; 5 - flexible hose; 6 - corrugated diaphragm; 7 - pipe union; 8 - base; 9 - wiper; 10 - rheostat; 11 - plug connector; 12 - brush holder; 13 - rocking lever; 14 - carrier; 15 - body; 16 - axle; 17 - return spring; 18 - rod; a - space

[redacted]

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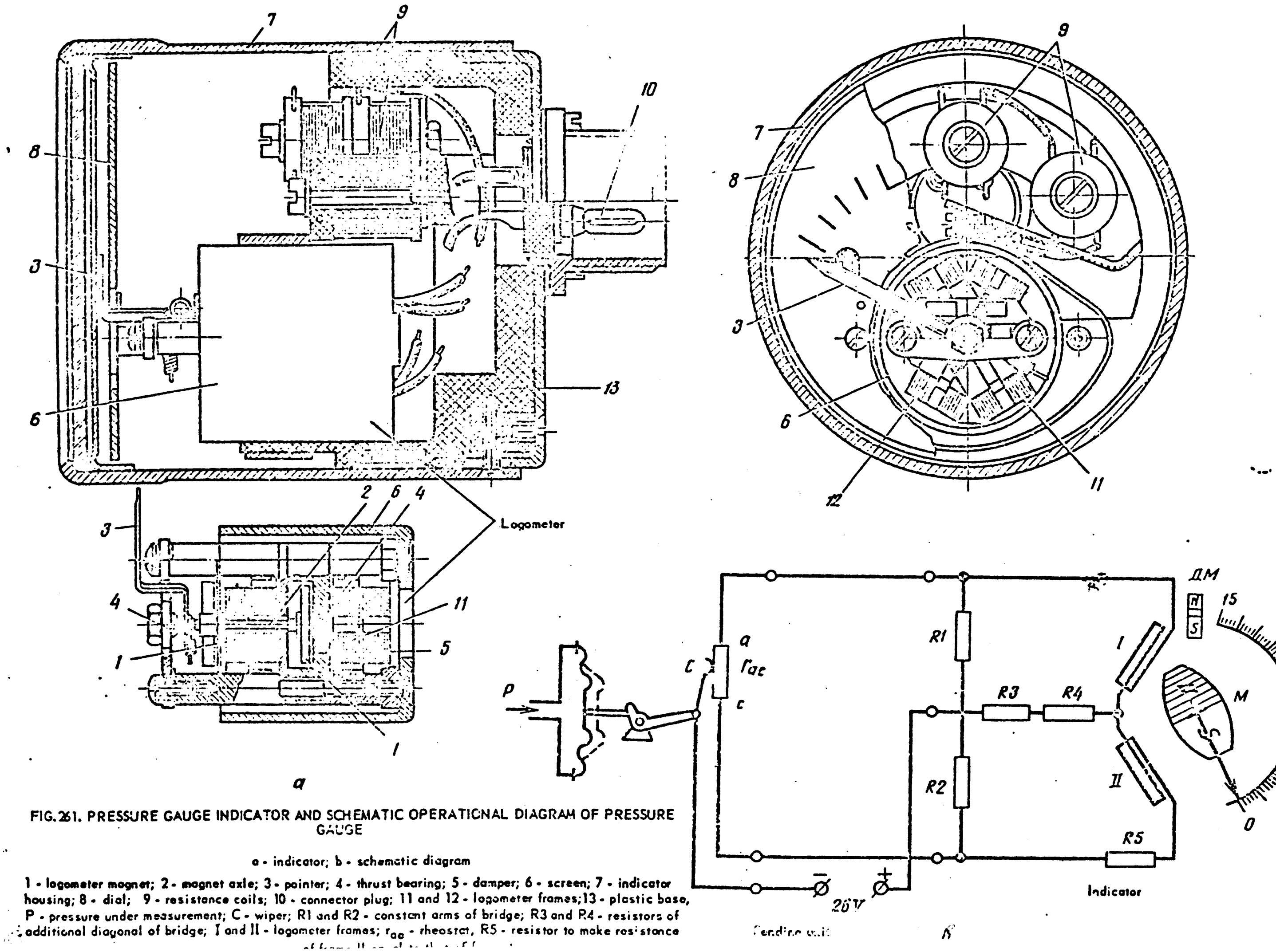

7
9
10
8
3
6
13
Logometer
2
6
4
11
5
1
a
ДМ
N
S
15
0
M
R1
R2
R3
R4
R5
I
II
a
rac
c
C
P
20V
Indicator
Sending unit
б

FIG. 261. PRESSURE GAUGE INDICATOR AND SCHEMATIC OPERATIONAL DIAGRAM OF PRESSURE GAUGE

a - indicator; b - schematic diagram

1 - logometer magnet; 2 - magnet axle; 3 - pointer; 4 - thrust bearing; 5 - damper; 6 - screen; 7 - indicator housing; 8 - dial; 9 - resistance coils; 10 - connector plug; 11 and 12 - logometer frames; 13 - plastic base, P - pressure under measurement; C - wiper; R1 and R2 - constant arms of bridge; R3 and R4 - resistors of additional diagonal of bridge; I and II - logometer frames; r_{ac} - rheostat, R5 - resistor to make resistance of frame II equal to that of I

[redacted]

[redacted]

Pressure gauge ЭДМУ-6-И is designed for remote measurement of the oil pressure in the lubricating system of the gearbox. Unlike pressure gauge ТЭМ-15, it has a scale graduated from 0 to 6 kgf/cm^2; this is the only difference between the pressure gauges.

The sending unit of the pressure gauge is secured on a bracket in the engine compartment and connected through a hose with the oil line running from the valve box to the gearbox.

Speedometer СП-106 is designed to measure the speed of the vehicle movement and count the distance covered.

The speedometer set includes sending unit 2 (Fig.262), indicator 1 and electric wire. The speedometer indicator scale is graduated from 0 to 100 km/h.

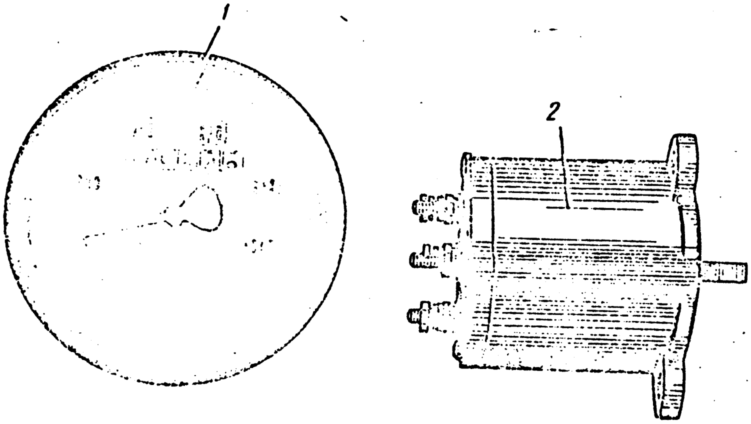

FIG.262. SPEEDOMETER СП-106

1 - indicator; 2 - sending unit

Sending unit МЭ-301 (Fig.263) is a commutator-type transducer. The basic components of the transducer are: body 5, commutator 3 made from two hollow shaped parts (segments), rocker 2 with two current-supply brushes 4 and three current-collecting brushes 7 and cover 1. The commutator segments are fitted on a common axle and insulated from each other. They are located on the cylindrical surface of the commutator and built into the insulating bushing fitted on the axle.

The direct current of the mains is delivered to the commutator segments through the slip rings and two brushes.

The sending unit of the speedometer is mounted on the gear case and put into action by the drive shaft of the final drive through a worm gearing.

The indicator (Fig.264) includes a synchronous three-phase electric motor, speed measurement unit and kilometrage counting unit.

Two-pole permanent magnet 5 secured on shaft 8 serves as the rotor of the electric motor. The winding of stator 1 is installed on three pole shoes and star-connected. The ends of the stator winding are connected to three output terminals 7 of the indicator. The rotor revolves in two ball bearings 6. The free end of the rotor shaft carries magnet 11 of the induction speed measurement unit. Rotation is imparted from shaft 8 to counting unit 2 of the indicator through a worm gearing.

The speed measurement unit of the speedometer is of an induction type; it consists of permanent magnet 11, dial 9 and a spring.

[redacted]

[redacted]

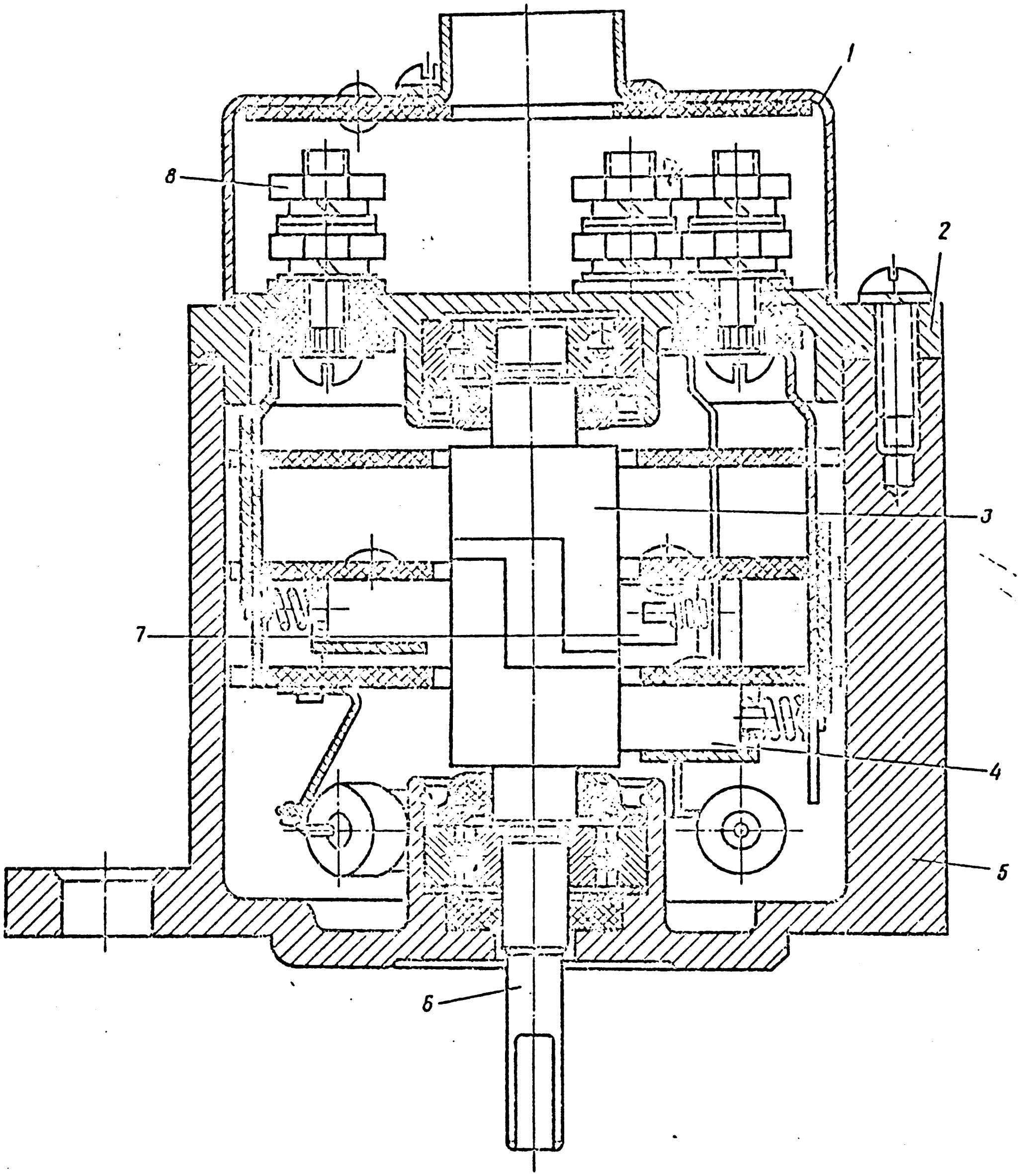

FIG.263. SENDING UNIT MD-301 OF SPEEDOMETER

1 - cover; 2 - rocker; 3 - commutator; 4 - current-supply brush; 5 - sending unit body; 6 - shaft; 7 - current-collecting brush; 8 - output terminals

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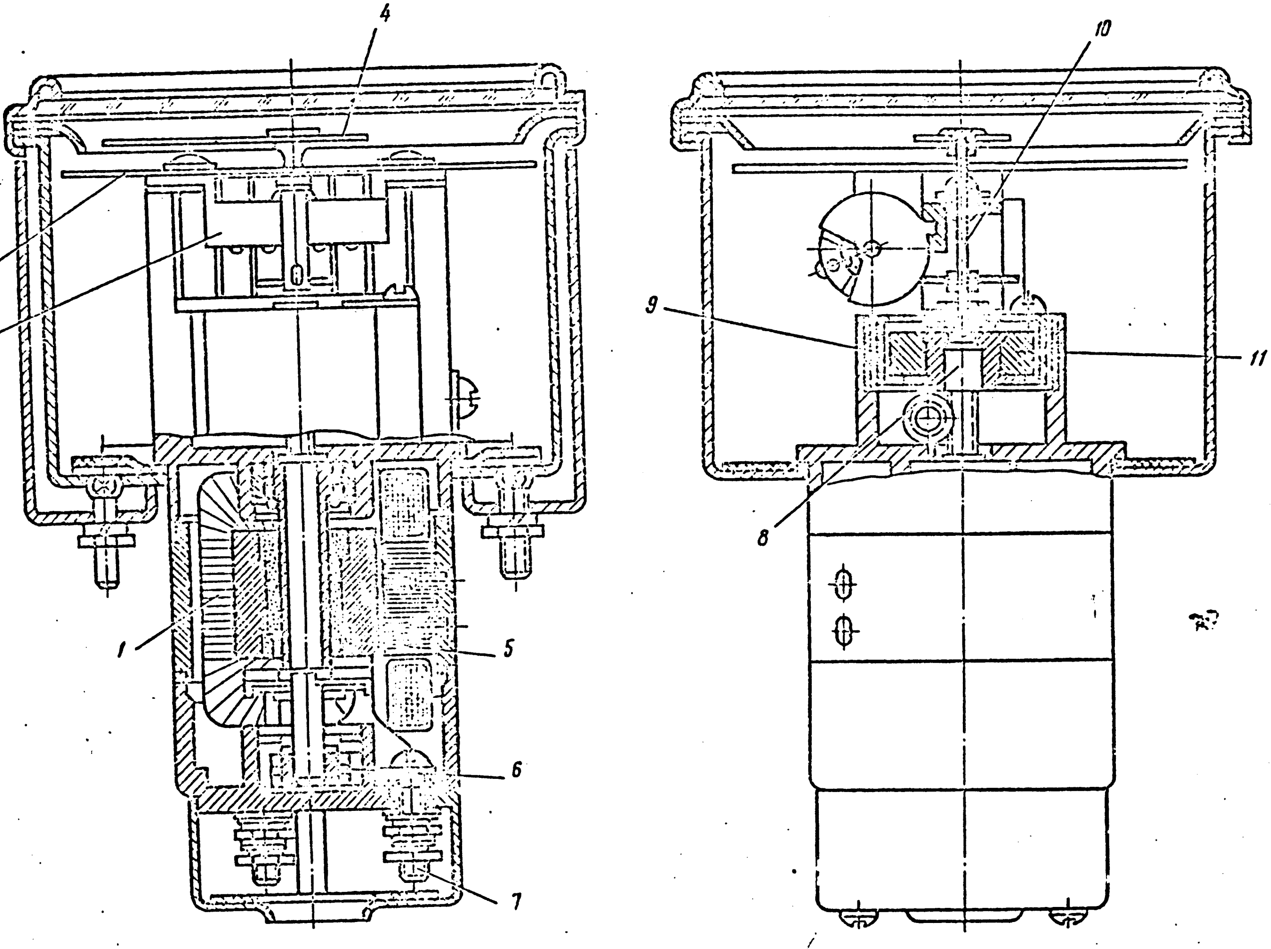

FIG. 264. SPEEDOMETER INDICATOR

1 - stator; 2 - counting unit; 3 - scale; 4 - pointer; 5 - permanent magnet; 6 - ball bearing; 7 - output terminals; 8 - shaft; 9 - dial; 10 - dial axle; 11 - magnet

[redacted]

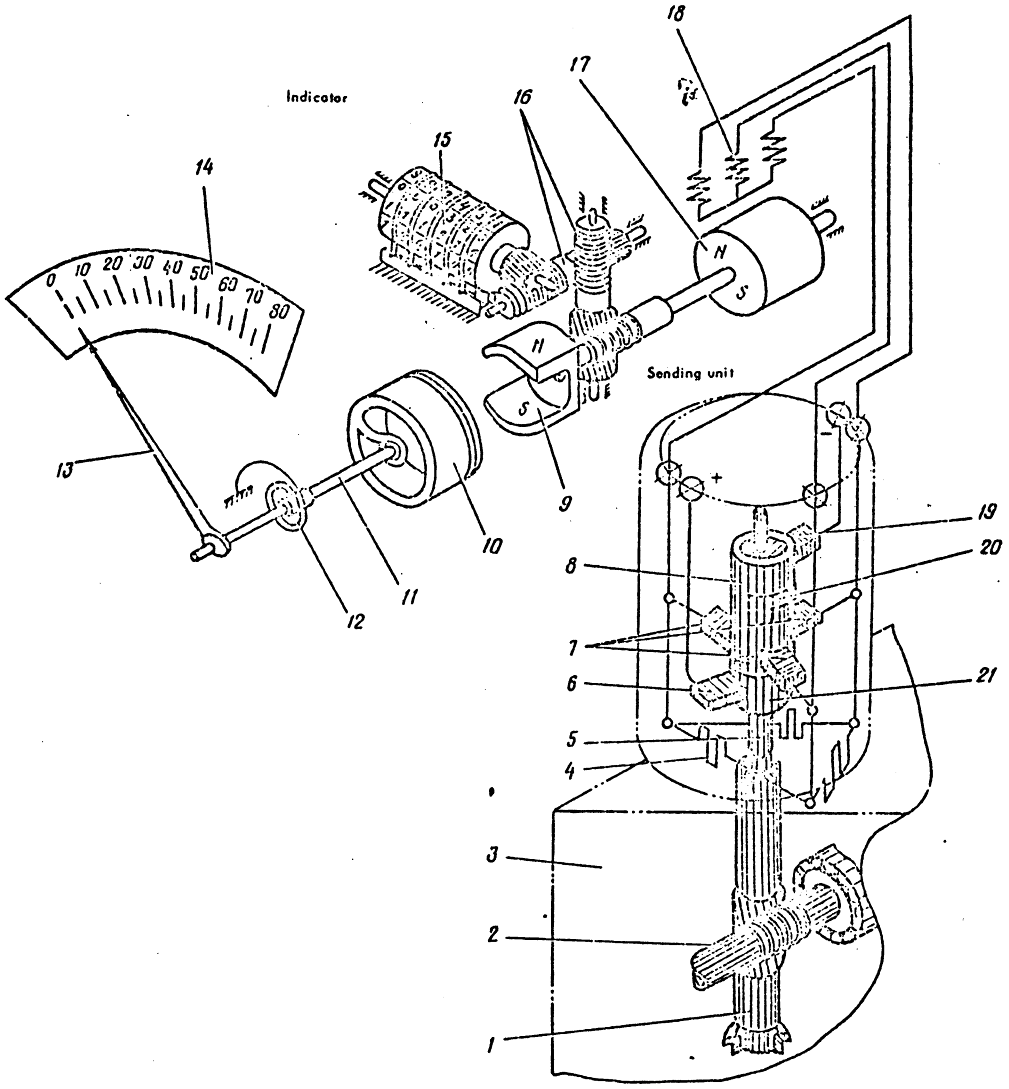
Indicator
Sending unit
18
17
16
15
14
0 10 20 30 40 50 60 70 80
N
S
N
S
+
−
13
12
11
10
9
8
7
6
5
4
3
2
1
19
20
21

FIG. 265. DESIGN AND OPERATING PRINCIPLE OF SPEEDOMETER

1 - speedometer drive shaft; 2 - drive shaft of left-hand final drive; 3 - gear case; 4 - resistor; 5 - shaft; 6 - plus brush; 7 - commutator brushes; 8 - minus slip ring with segment; 9 - permanent magnet; 10 - dial; 11 - axle; 12 - spring; 13 - pointer; 14 - scale; 15 - kilometrage counter; 16 - worm gearings; 17 - indicator rotor; 18 - stator winding; 19 - minus brush; 20 - commutator; 21 - plus slip ring with segment

[redacted]

The dial is fitted on axle 10, embracing the permanent magnet. The end of the dial axle holds speedometer pointer 4. The speed measurement unit operates as follows. With rotor shaft 8 revolving, magnet 11 rotates together with it, and the magnetic flux induces an electromotive force in dial 9. The electromotive force is proportional to the rotational speed of the magnet. An electric current generated in the dial induces a magnetic field interacting with the field of the rotating magnet, and thus causing a torque.

The angle of deflection of the dial and pointer is proportional to the rotational speed of the rotor (magnet).

A spiral spring (hair) secured on the dial axle prevents rotation of the dial together with the magnet and counterbalances the torque produced as a result of interaction of the magnetic fields.

The counting unit is of a mechanical type; it consists of six drums counting the kilometrage covered, and worm gearings. The rotor shaft revolves the right-hand drum (counting tenths of a kilometre) through a system of worm gearings. After the right-hand drum completed the tenth revolution, the neighbouring drum turns, recording 1 km; the other drums turn in succession in a similar way, thus recording the kilometrage covered.

The speedometer functions as follows.

With the vehicle moving, the drive shaft of the final drive actuates shaft 1 of the sending unit (Fig.265), and consequently, commutator 20. The mains direct current applied to the commutator through brushes 6 is inverted into a three-phase pulsating current whose frequency is directly proportional to the rotational speed of the commutator.

This current flows over wires to winding 18 of the indicator motor stator. The rotating field formed in the stator makes rotor 17 of the electric motor to revolve together with magnet 9 of the speed measurement unit at a speed proportional to the rotational speed of the drive shaft of the final drive, and consequently to the speed of the vehicle movement. Permanent magnet 9 actuates dial 10 of the speed measurement unit, and thus causes indicator pointer 13 to deflect. Simultaneously, the shaft of rotor 17 drives counting unit 15 through worm gearings 16.

Rotary limit switch

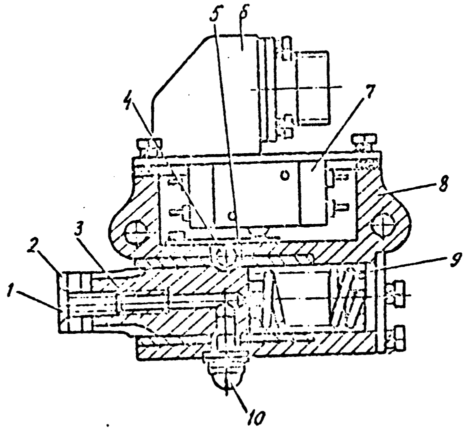

FIG.266. ROTARY LIMIT SWITCH

1 - screw; 2 - lever; 3 - spring-loaded plunger; 4 - retainer; 5 - plate; 6 - plug connector; 7 - microswitch; 8 - body; 9 - spring, 10 - locking screw

9.3.7. Switching Devices

The vehicle is provided with limit switches of two types: push-type and rotary. For the design and operation of a push-type limit switch see Subsection 9.3.4.

The design of a rotary switch slightly differs from that of a push-type switch. The difference is that a rotary switch has spring-loaded plunger 3 (Fig.266) with lever 2 instead of rod 2 (Fig.247) with screw 1.The lev is secured with screw 1. Besides, the switch is provided with retainer 4. Placed between spring-loaded plunger 3 and retainer 4 is torsional spring 9.

As lever 2 is pressed, spring-loaded plunger 3 turns, and the ball which is forced out of the recess of spring-loaded plunger, pushes the button of microswitch 7 through plate 5. As a result of plate movement, one pai of contacts opens, and the other pair, closes.

The push-type limit switches are mounted:

- on the gun lock;
- on the levers drive reduction gear;

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[redacted]

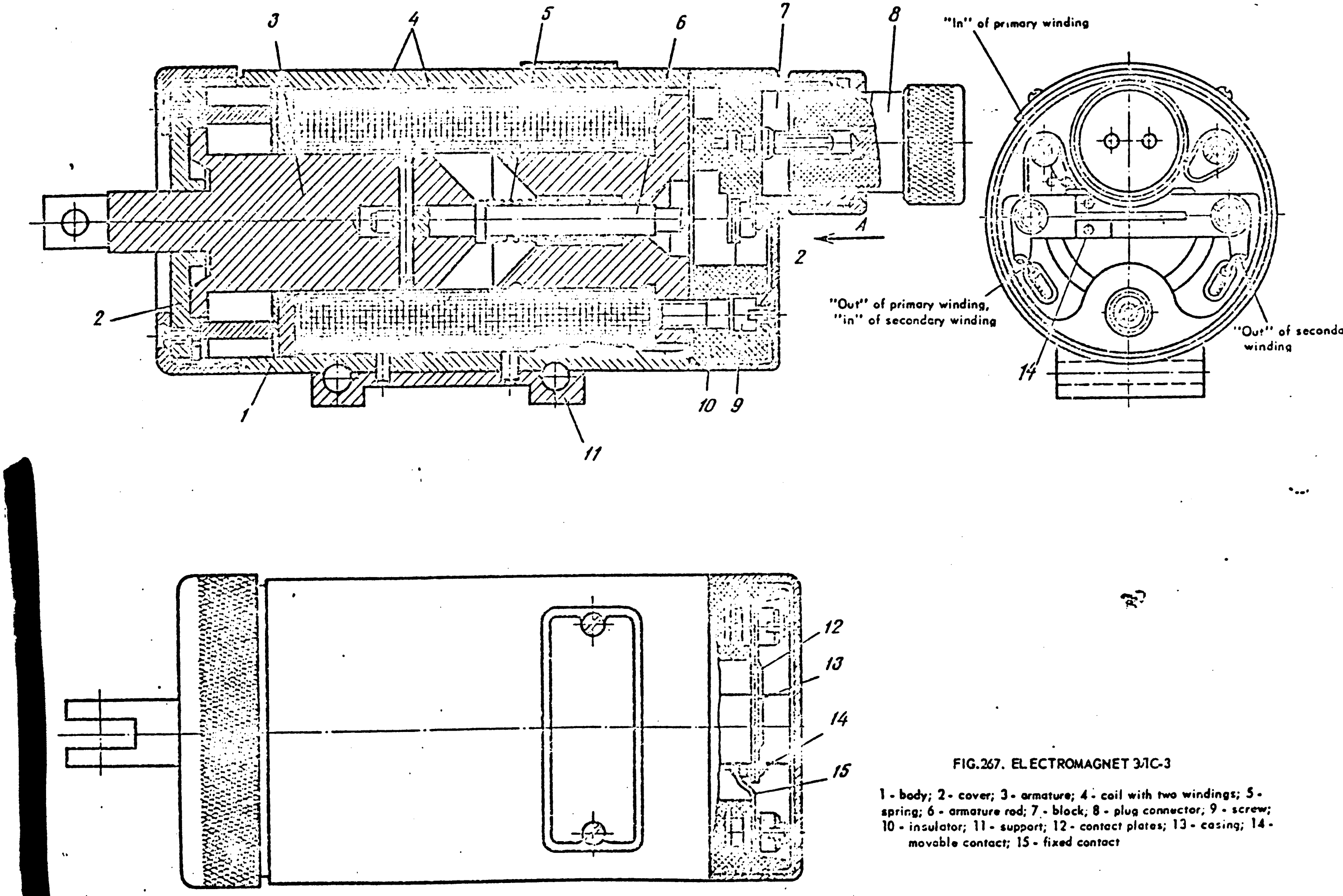
3
4
5
6
7
8
"In" of primary winding
A
2
2
"Out" of primary winding, "in" of secondary winding
"Out" of seconda
winding
14
1
10
9
11
12
13
14
15

FIG.267. ELECTROMAGNET ЭЛС-3

1 - body; 2 - cover; 3 - armature; 4 - coil with two windings; 5 - spring; 6 - armature rod; 7 - block; 8 - plug connector; 9 - screw; 10 - insulator; 11 - support; 12 - contact plates; 13 - casing; 14 - movable contact; 15 - fixed contact

[redacted]

[redacted]

- on the trough-catch;
- on the rammer reduction gear;
- on the conveyor drive reduction gear;
- on the bracket of gun laying control panel (two switches);
- on the turret race ring along gun longitudinal axis (maximum elevation angle limit switch);
- on the bracket of ПКТ machine gun (maximum depression angle limit switch);
- on the rear cross beam of the roof at the doors;
- on the roof of the driving compartment at the driver's hatch cover closing mechanism;
- on the commander's hatch cover;
- on the parking brake control rack retainer body;
- on the cross beam in engine compartment (for the engine protection valves);
- on the detachable plate of engine compartment roof (louvres);
- on the gear case (engagement of brake pneumatic control);
- over retainer control pedal 25 (Fig.68);
- on the exhaust blower valve body, and on СПТ valve box branch pipe.

The rotary limit switches are mounted:
- on the conveyer frame (presence of round on conveyer);
- on the trough-catch (presence of round on trough);
- on the turret roof to the left of the ATGM feed hatch.

Electromagnet ЭЛС-3 (Fig.267) consists of body 1, coil 4 with one cut-in and one holding windings, armature 3 with return spring 5, block with contact plates and plug connector 8.

The contact plates serve to change over the electromagnet from the cut-in winding to the holding winding when the armature develops full speed. The operating principle of the electromagnet is similar to that of the contactor described in Subsection 9.3.2.

When the voltage is applied to the windings of coil 4, armature 3 displaces for 13 mm under the action of the electromagnetic field, developing a traction force of 10 to 20 kgf.

Electromagnets ЭЛС-3 are mounted:
- on the conveyer drive reduction gear (conveyer lock);
- on the gun breech ring (gun lock);
- on the levers drive reduction gear (reduction gear brake);
- in the engine compartment (engine protection valves);
- on the engine compartment bottom (engine shut-down mechanism).

Electromagnet РП-1 (Fig.268) consists of body 2, coil 1 having one winding, armature 3 and two terminal bolts 5.The operating principle of the electromagnet is similar to that of electromagnet ЭЛС-3.

Electromagnets РП-1 are mounted:
- on the body of valve of smoke-generating system;
- on the valve box of each of three exhaust blowers;
- on the gun lock (lock latch);
- on the valve box of special blower of filter-ventilating unit;
- on the cross beam of engine compartment (louvres lock).

Turret collector ring box ВКУ-330-1 is designed to transmit the power from the vehicle mains to the rotating turret, and also to connect the control boxes of the tank interphone system arranged in the hull and turret.

The turret collector ring box (Fig.269) is located on the vehicle floor; it consists of two parts: lower stationary part and upper rotating part.

The upper part revolves on ball support 8. The joint is packed with cup 6.

The face side of the turret collector ring box has eight plug connectors to connect the wires running from the power supply sources and to the turret consumers. The box incorporates heavy-current and weak-current contact systems and sending unit of gun position signal lamp (operating at angles exceeding ±27°).

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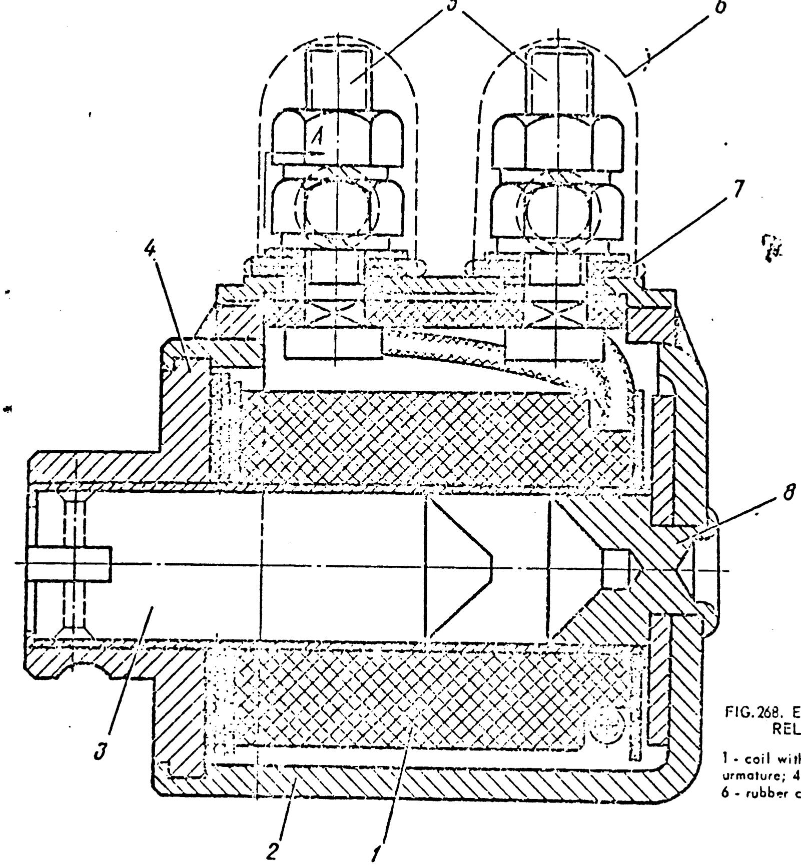

FIG. 268. ELECTROMAGNET (TRACTIVE RELAY) PII1

1 - coil with one winding; 2 - body; 3 - armature; 4 - cover; 5 - terminal bolts; 6 - rubber cap; 7 - gaskets; 8 - core

The weak-current contact system consists of a stationary part rigidly secured on bases 26 and 34 and movable part which is connected with the upper part of the turret collector ring box.

The stationary part of the contact system consists of internally-toothed slip rings 27, current-supply rings 28 and spacers 29 isolating the current-supply rings (electric circuits) from each other. Placed between each pair of fixed slip rings are movable slip rings 27, 0.1 mm thick. To ensure better contact, the inner teeth of fixed rings 40 are bent towards movable rings 27. The movable rings loosely fitted on a carrier can move (float) over the latter. Their displacement is limited by fixed discs, and thus better contact is provided.

The wires running from the plug connectors are connected to the fixed and movable rings. The mains current is applied to the plug connector of the stationary part of the turret collector ring box. From the plug connector of the upper part the wires run to the turret consumers. The weak-current system includes ten electric circuits.

The heavy-current contact system consists of a stationary and a movable part.

The stationary part consists of four internally-toothed slip rings 40 and 41, two insulating spacers 42 and current-supply bus-bar 44. To provide better contact, each disc of the movable contact is placed between two slip rings of the fixed contact.

Movable contacts 43 represent a tube carrying a welded contact disc which is placed between two slip rings whose tooth slide over the contact surfaces of the disc. The movable

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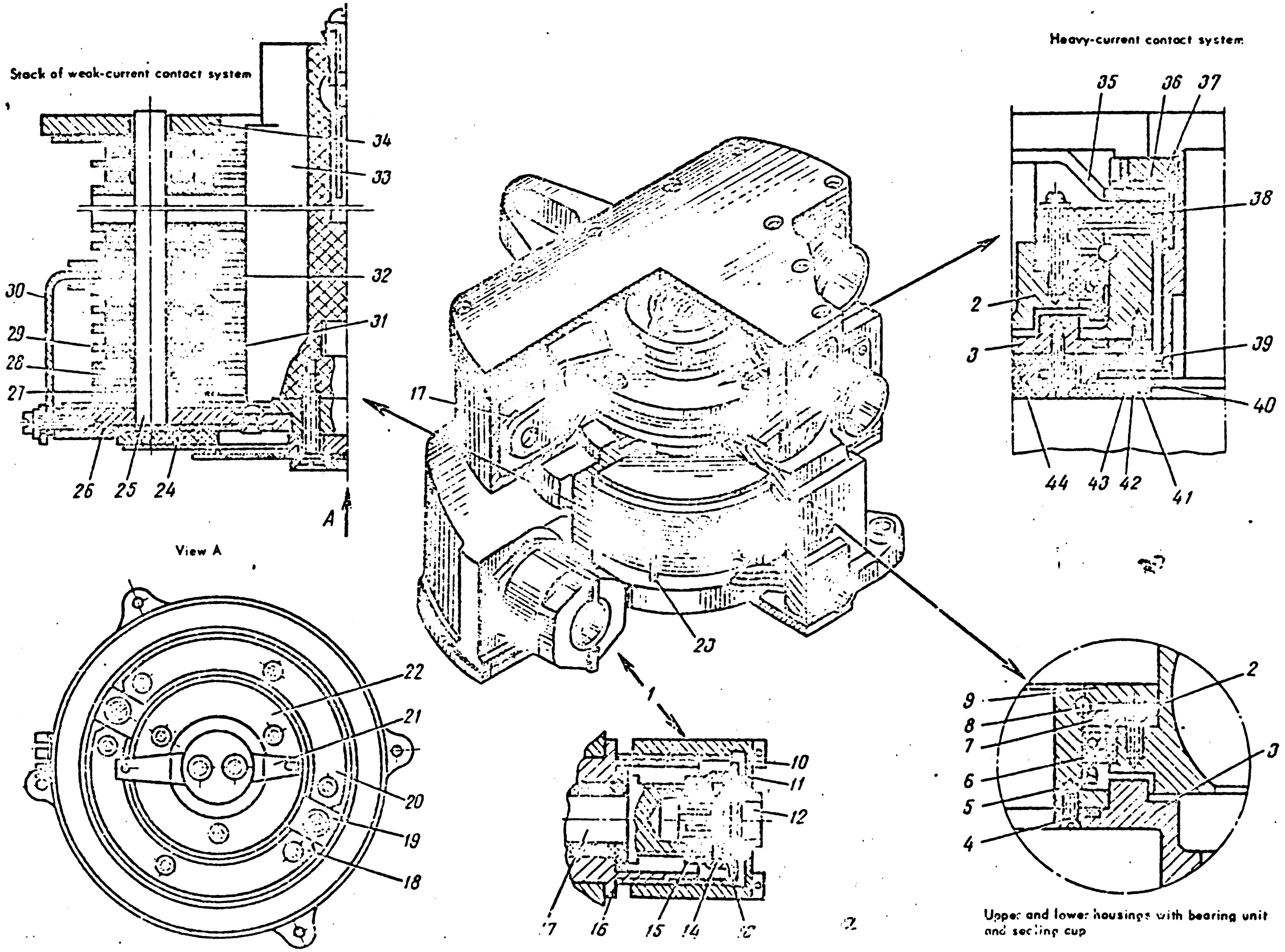

Stack of weak-current contact system

View A

Heavy-current contact system

Upper and lower housings with bearing unit and sealing cup

1
2
3
4
5
6
7
8
9
10
11
12
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
A

[redacted]

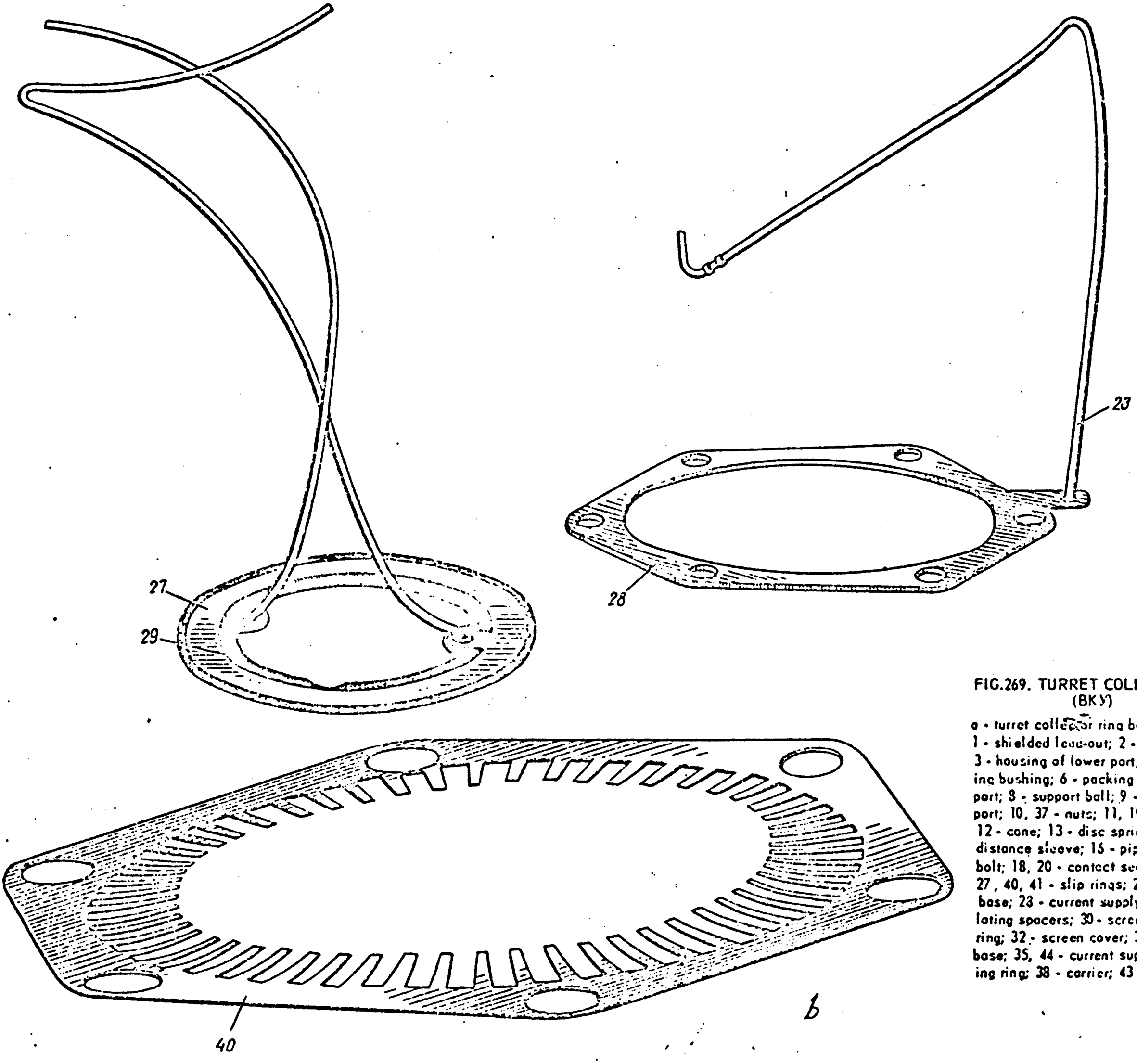

FIG.269. TURRET COLLECTOR RING BOX (BKY)

a - turret collector ring box; b - rings; 1 - shielded lead-out; 2 - housing of upper part; 3 - housing of lower part; 4 - screw; 5 - supporting bushing; 6 - packing cup; 7 - ring of ball support; 8 - support ball; 9 - upper ring of ball support; 10, 37 - nuts; 11, 19, 24 - insulating rings; 12 - cone; 13 - disc spring; 14 - union nut; 15 - distance sleeve; 16 - pipe union; 17 - terminal bolt; 18, 20 - contact segments; 21 - brush, 22, 27, 40, 41 - slip rings; 23, 25 - studs; 26 - lower base; 28 - current supply ring; 29, 39, 42 - insulating spacers; 30 - screen casing; 31 - movable ring; 32 - screen cover; 33 - carrier; 34 - upper base; 35, 44 - current supply bus-bars; 36 - locking ring; 38 - carrier; 43 - movable contact

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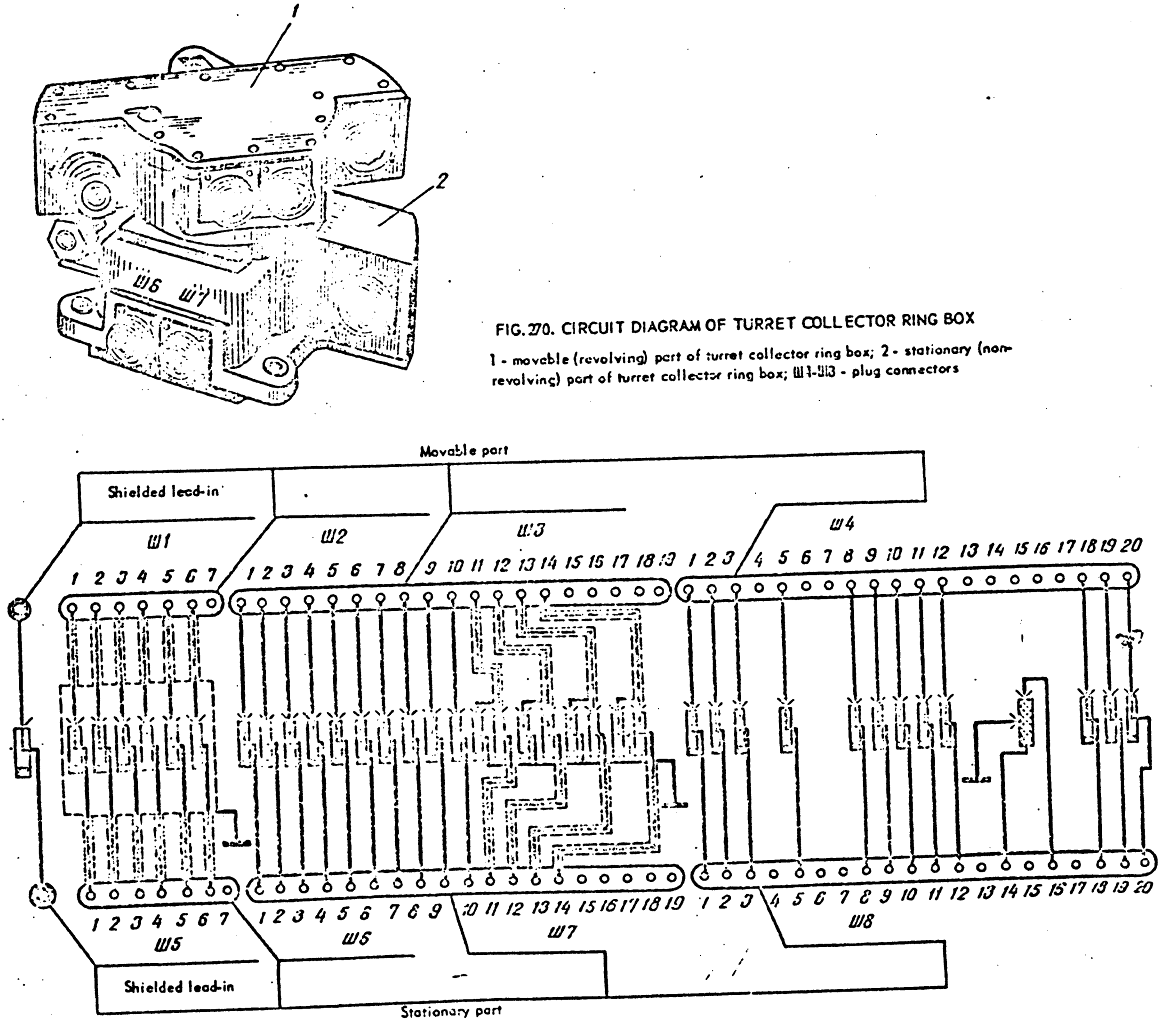
1
2
Ш6
Ш7
Movable part
Shielded lead-in
Ш1
Ш2
Ш3
Ш4
1 2 3 4 5 6 7
1 2 3 4 5 6 7 8
9 10 11 12 13 14 15 16 17 18 19
1 2 3
4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
1 2 3 4 5 6 7
Ш5
1 2 3 4 5 6 7 8 9
Ш6
10 11 12 13 14 15 16 17 18 19
Ш7
1 2 3
4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Ш8
Shielded lead-in
Stationary part

FIG. 270. CIRCUIT DIAGRAM OF TURRET COLLECTOR RING BOX

1 - movable (revolving) part of turret collector ring box; 2 - stationary (non-revolving) part of turret collector ring box; Ш1-Ш8 - plug connectors

carrier.

With the turret revolving, the pin connected with the floor of the fighting compartment rotates the movable part of the turret collector ring box through the carrier.

The circuit diagram of the turret collector ring box is given in Fig.270.

The turret collector ring box is designed for transmission of electric power over 33 circuits including one circuit which serves for continuous delivery of a 360-A current, and two circuits which are rated at 30 A. These circuits are shielded by a special ferromagnetic screen. They supply the turret electric drive and loading mechanism.

The weak-current circuits supply the lights, signal lamps of the tank interphone system, and other consumers. Besides, the turret collector ring box supplies the gun position signal lamps.

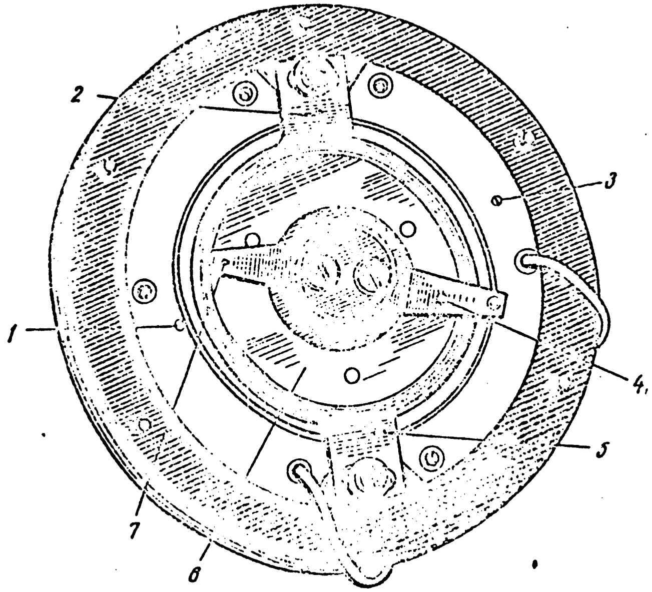

FIG.271. GUN POSITION SIGNAL LAMP CIRCUIT

1 and 3 - contact segments; 2 and 5 - insulating sections; 4 - current-collecting brush; 6 - contact disc; 7 - current-supply brush

The sending unit of the gun position signal lamp (Fig.271) is mounted in the lower part of the turret collector ring box. It includes contact disc 6, two contact segments 1 and 3, movable brush 4 and two insulating sections 2 and 5.

The brush is connected with the revolving part of the turret collector ring box, which, in its turn, is connected with the turret. When the gun is beyond the vehicle width, brush 4 gets on one of contact segments (1 or 3), and the current flows from contact disc 6 to the signal lamp circuit through brushes 7 and 4; as a result, the signal lamp lights up.

The purpose of separate circuits of the turret collector ring box is shown in Fig.272.

The electric power is transmitted to the consumers mounted on the rotating cover of the commander's hatch by means of a separate turret collector ring box. It includes three slip rings, collecting and contact current-supply devices.

From the collecting device the current passes to vision device ТКН-3 (to supply and heat the latter), to spotlight ОУ-3ГА2, limit switch of the commander's hatch cover and the spotlight on/off button.

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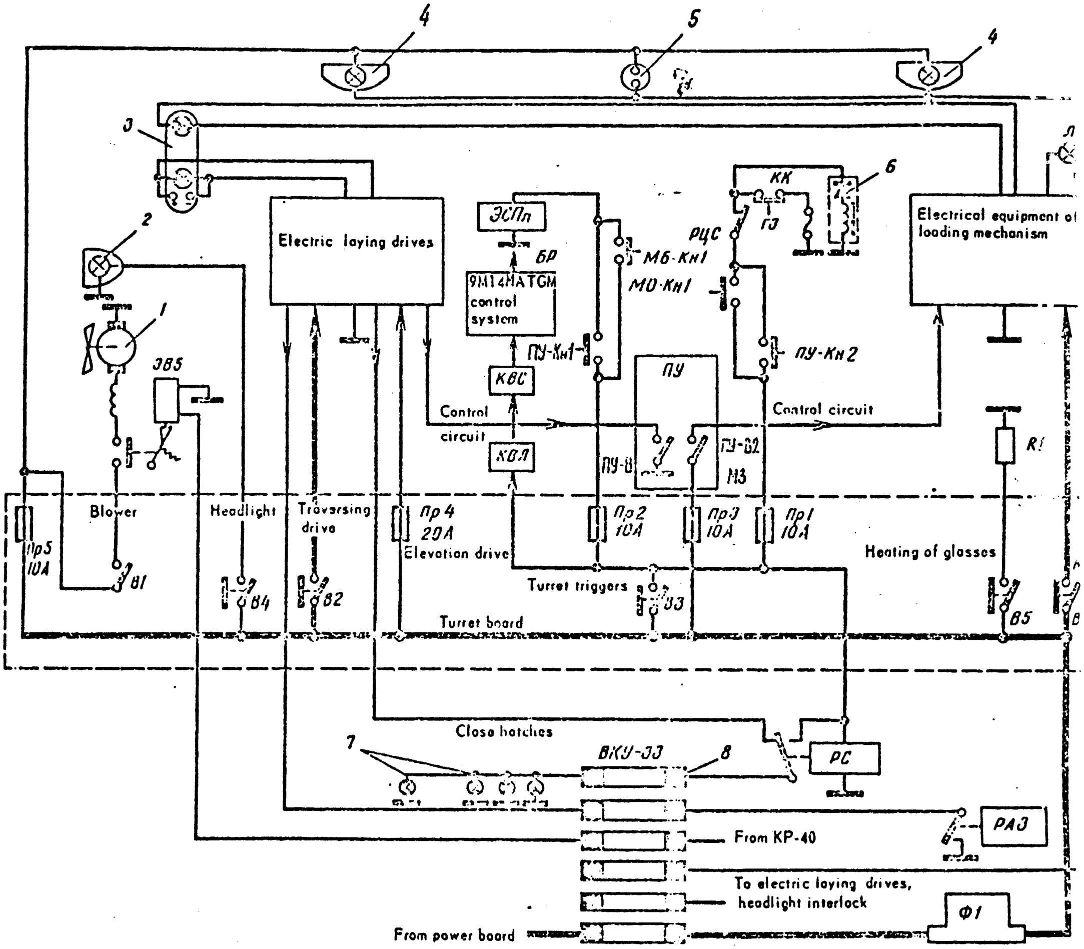
4
5
4
3
2
1
ЭВБ
6
Л
Electric laying drives
ЭСПп
БР
9M14M ATGM control system
ПУ-Кн1
КВС
КВЛ
Control circuit
МБ-Кн1
МО-Кн1
КК
ГЗ
РЦС
ПУ-Кн2
ПУ
ПУ-В
ПУ-В2
МЗ
Control circuit
Electrical equipment of loading mechanism
R
Blower
Headlight
Traversing drive
Пр5 10А
Пр4 20А
Elevation drive
Пр2 10А
Пр3 10А
Пр1 10А
Heating of glasses
В1
В4
В2
Turret triggers
В3
В5
В6
Turret board
Close hatches
7
ВКУ-33
8
РС
РАЗ
From KP-40
To electric laying drives, headlight interlock
Ф1
From power board

FIG.272. BLOCK-DIAGRAM OF TURRET ELECTRICAL EQUIPMENT

1 - exhaust blower of turret; 2 - swivelling headlight ФГ-126; 3 - signal board of turret; 4 - service dome lamps; 5 - service socket; 6 - duplicating generator; 7 - signal lamps CLOSE HATCHES; 8 - ВКУ-330-1; ЭВБ - electromagnet of turret blower; ЭСПп - machine gun electric trigger; ПУ-Кн1 - button of machine gun electric trigger (on left-hand handle of control unit); МБ-Кн1 - button of mechine gun electric trigger (on handle of turret traversing mechanism); ГЗ - primer; KK - contacts of breechblock;РЦС - relay of loading mechanism firing circuit; ПУ-Кн2 - electric prime button on elevating handle; Г - glass heating; КВЛ - limit switch of operator's hatch; KBC - limit switch of 9M14M missile guide rail lock retainer; ПУ-В - laying drive switch; ПУ-В2-М3 - loading mechanism switch; ПУ - control unit; Л - red signal lamp KEEP OFF LOADING MECHANISM; PC - trigger relay; PA3 - atomic protection relay; Ф1-radio interference filter;БР- missile connector; B1, B2, B3, B4, B5 and B6 - switches on turret board

[redacted]

[redacted]

power supply source to the vehicle mains for starting the engine.

Socket 5 (Fig. 227) is mounted on the rear wall of the battery compartment. For connecting the cable of the external power supply source to the socket, open the right-hand door.

The socket (Fig.273) consists of base 3 and cover 4 manufactured from fibrous material. The cover and the base hold plus jumper 2 and minus jumper 1.

The plus jumper is connected with the terminal of the battery contactor, and the minus jumper, with the vehicle body.

The socket has jacks 7 to receive special knife lugs of the wires of the external power supply source. Strap 5 and springs 6 reliably press the lugs to contact jumpers 1 and 2.

To connect the external power supply source, do the following:

- switch off the battery contactor;
- insert the lugs of the cables of the external power supply source in the jacks observing the polarity;
- switch on the contactor.

Circuit breakers АЗС-5 serve to switch on the current consumers and protect them (switch them off) at short-circuits and overloads.

The circuit breaker (Fig.274) is a combination of a single-pole switch and thermal bimetallic element ensuring automatic disconnection of consumers.

The circuit breaker consists of a body, leverage with a handle and thermal bimetallic element.

The circuit breaker functions as follows: as current passes through bimetallic plate 7, it heats; if the current intensity exceeds the permissible value, the plate deflects and opens contacts 3 and 4. As a result of plate deflection, angle 8 moves from under the stop of block 6. Actuated by disengaging spring 5, block 6 moves to the left, turns handle 1 and opens contacts 3 and 4. The contacts may be opened manually with the help of handle 1; in this case, the circuit breaker is used as a switch.

The purpose of the circuit breakers (switches) mounted on the central panel is given in Fig.246.

Switches, change-over switch and buttons. The vehicle is provided with single-pole switches В-45М, single-pole push-type switch ВК-45М, single-pole change-over switch ППН-45 (having a neutral position) and buttons.

Single-pole switch В-45М is designed to switch on and off the consumers. The switch design is shown in Fig.275.

The switch consists of base 1, casing 2, lever 5 with pressure piece 4 and spring 6, and movable contact strap 7.

The mains is connected to one of terminals 9, and the consumer, to the other terminal. When the switch is cut in, terminals 9 are closed with contact strap 7, pressed to left terminal 9 by insulating pressure piece 4. As lever 5 is shifted to another position, contact strap 7 moves away from left terminal 9, and the contacts open.

9.3.8. Radio Interference Filters

There are three radio interference filters on the vehicle: two filters, type Ф-5, and one filter, type Ф-1.

One filter is located under the operator's seat, the second one, in the battery compartment, and the third one, on the left side of the front sloping plate.

Filter Ф-5 (Fig.276) consists of a choke which is, essentially, circular iron core 4 with winding 3, two duct capacitors 5 (employing U-shaped circuit), and two screened leads 6.

The operating principle of the filter is based on a high inductive resistance of the choke to the alternating current, and on the alibity of the capacitors to pass radio-frequency currents. Radio-frequency currents interfering with radio reception, are retained

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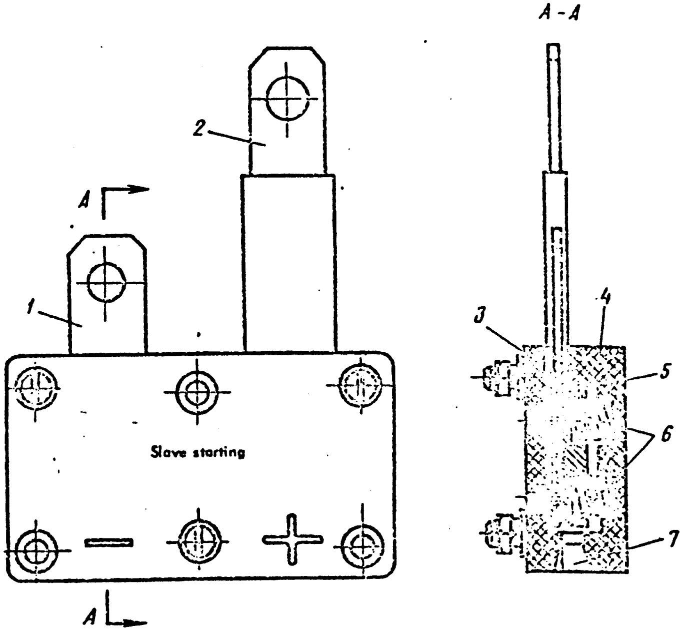
A - A
A
A
1
2
3
4
5
6
7
Slave starting

FIG.273. SLAVE STARTING SOCKET

1 - minus jumper; 2 - plus jumper; 3 - base; 4 - cover; 5 - strap; 6 - spring; 7 - jack

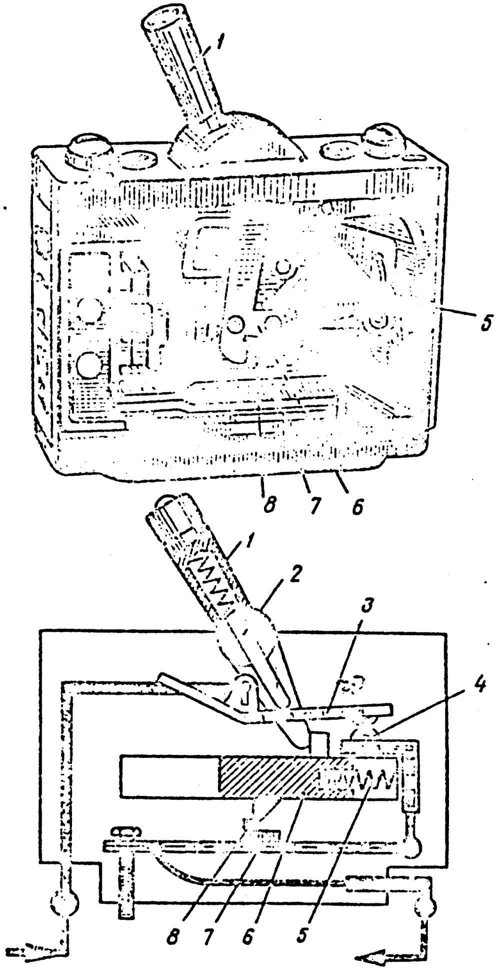
1
5
8
7
6
1
2
3
4
8
7
6
5

FIG.274. CIRCUIT BREAKER

1 - handle; 2 - pressure piece; 3 - movable contact; 4 - fixed contact; 5 - disengaging spring; 6 - block; 7 - bimetallic plate; 8 - angle

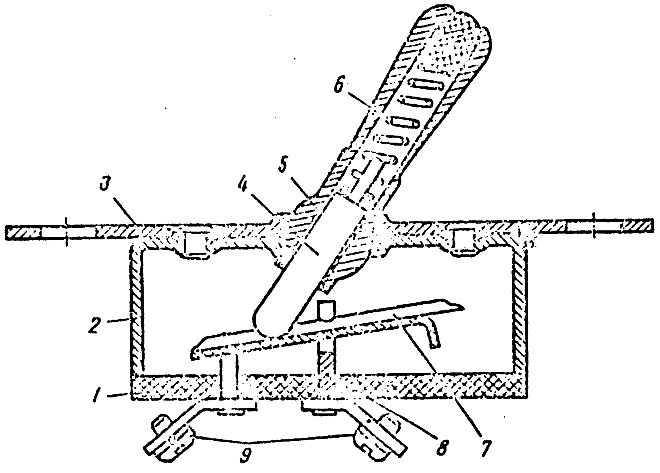

FIG.275. SWITCH B-45M

1 - base; 2 - casing; 3 - strap; 4 - pressure piece; 5 - lever; 6 - spring; 7 - movable contact strap; 8 - contact post; 9 - terminals

by the choke, and closed through the capacitors to the vehicle body, past the wires of the electrical system and the radio station.

The filter capacitor is a thin-walled body accommodating two rolled thin aluminum bands (plates) insulated from each other with capacitor paper. Two capacitor conductors (plates) that are insulated with thin dielectric, possess a capacitance.

When one of the plates is connected to a power source, the plates accumulate an electric charge, and an electric field is induced in the dielectric. As the voltage in the circuit of the power supply source (A.C.) changes abruptly, opposed currents appear in the capacitor plates due to the potential difference across the latter; the opposed currents do not let the voltage change abruptly in the circuit of the power supply source. When the other plate is connected to the body, the radio-frequency currents are closed to the body.

Filter Ф-1 differs from filter Ф-5 by its characteristic only.

9.3.9. Electric Wires

The following wires are used in the vehicle: wires, grades БПВЛЭ, БПВЛА, БПВЛ and ПТЛЭ, having cross-sectional areas of 0.5; 0.75; 1; 1.5; 2.5; 4; 6; 16; 35; 50; 70 and 95 mm^2, depending on the power of the consumers.

9.4. CARE OF ELECTRICAL EQUIPMENT

9.4.1. General

The care of the electrical equipment melts down to regularly checking:
- the battery charging current and mains voltage;
- the instruments for proper functioning by the deflection of the indicator pointers;
- the external and internal lights for condition;
- the headlights, lights and horn for attachment;
- the starter and its wires for proper attachment, and the starter for proper installation;

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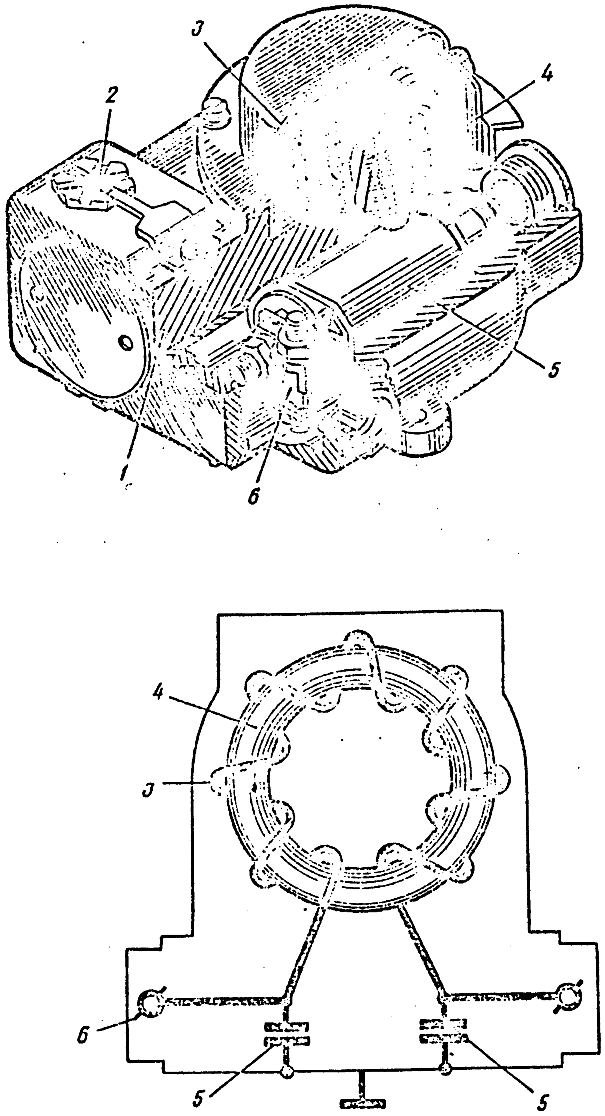

FIG.2/6. RADIO INTERFERENCE FILTER

1 - filter body; 2 - cover; 3 - choke winding; 4 - choke core; 5 - capacitor; 6 - screened lead

[redacted]

- the headlights for proper adjustment.

9.4.2. Adjusting the Position of Headlight ФГ-127

To adjust the position of headlight ФГ-127, proceed as follows:

- place the vehicle on a level site;
- place a screen at a distance of 5±0.5 m from the headlight so that the longitudinal axis of vehicle 5 (Fig.277) is perpendicular to the plane of screen 6;

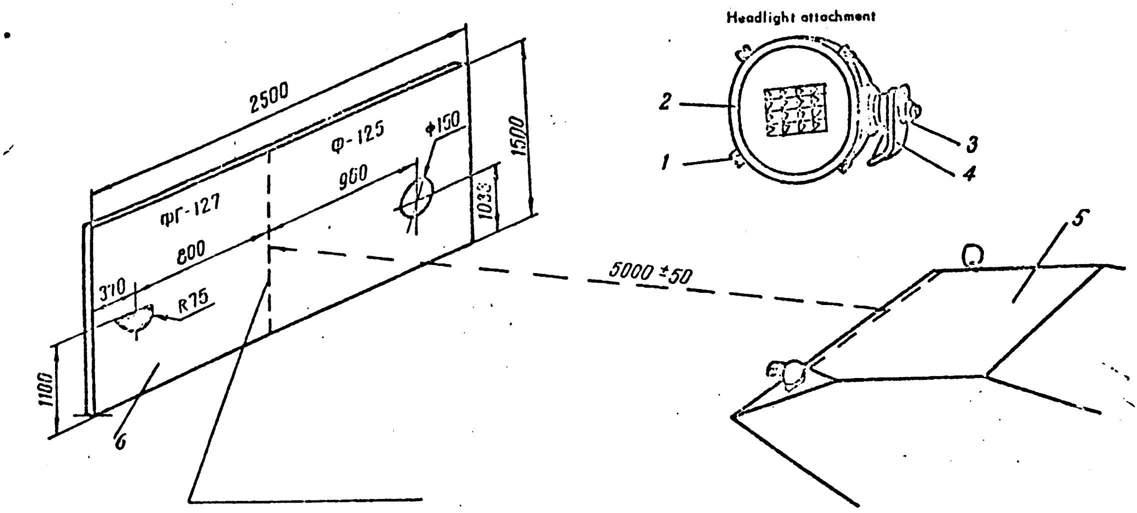

FIG.277. HEADLIGHT ADJUSTMENT
1 - bolt; 2 - headlight; 3 - headlight securing nut; 4 - bracket; 5 - vehicle; 6 - screen

- draw two vertical lines on the screen: one (middle), against the vehicle axis, and the other, against the centre of headlight ФГ-127, and one horizontal line, at a height of 1100 mm;
- turn on headlight ФГ-127, with the blackout device not used;
- loosen nut 3 of the headlight until the latter can be turned by the hand effort;
- turning the headlight, so that the bright spot lies on the vertical line, and the shadow cast by the visor, i.e. the sharp boundary between the illuminated and dark areas is at the height of the horizontal line on the screen:
- tighten up nut 3, taking care not to disturb the adjusted position of the headlight; and turn off the latter.

9.4.3. Adjusting the Position of Infrared Headlight ФГ-125

Check and adjust headlight ФГ-125 having an infrared filter in darkness on a level section of road (terrain) with the use of objects that are at a distance of 20 and 35 m from the vehicle.

Proceed with the check and adjustment as follows:

(a) Place the vehicle on a level site.

[redacted]

vehicle. The observed object must lie strictly on the continuation of the longitudinal axis of the vehicle.

(c) Install night vision device ТВНО-2 in the well instead of driver's middle device ТНПО-170 and connect the high-voltage cable of the power pack to the device. Place device ТНПО-170 in the ТВНО-2 device box.

(d) Switch on the power pack of device ТВНО-2 and right-hand headlight ФГ-125.

(e) Loosen the nut securing headlight ФГ-125 on the bracket so that it can be turned by the hand effort.

The driver should observe the object through device ТВНО-2, and the vehicle commander should turn and tilt the headlight, aligning the centre of the light beam of the headlight with the base of the object on the road. Tighten up the securing nut, taking care not to disturb the adjusted position of the headlight, and turn off the latter.

The accuracy of matching of infrared headlight ФГ-125 with vision device ТВНО-2 is determined at night by the best visibility of the object base through the vision device.

(f) Remove the beam unit from the left-hand headlight (or from the headlight mounted on the turret) and install the beam unit having an infrared filter (taken from the SPTA set) instead of it.

(g) Turn on the left-hand headlight (or the headlight mounted on the turret) having an infrared filter and perform the operations prescribed for the right-hand headlight on placing an object at a distance of 35 m from the vehicle.

(h) Switch off the power pack of the vision device and the left-hand headlight (or the headlight mounted on the turret) having an infrared filter.

9.5. TROUBLES AND REMEDIES

Trouble	Cause	Remedy
Charging current is not steady, voltammeter pointer fluctuates by more than one division	Generator commutator burnt and dirty	Remove protective band, wipe commutator, and clean it with glass paper "00", if necessary
	Generator brushes worn out or do not adhere closely	Lap or replace brushes
	Poor contact in any point of charging circuit	Check wires for secure attachment to terminals Clean loose terminal and tighten it up
Voltammeter does not indicate charging current	Wire connecting terminals "Ш" on generator and voltage regulator РН-10	Check wires and reliably attach them to terminals
	Poor contact between regulator РН-10 and body	Restore contact with body
	Regulator РН-10 faulty	Send regulator to repair
	250-A safety fuse on power board is blown	Replace safety fuse, find out and eliminate cause of trouble
	Generator faulty	Find out cause of trouble, and replace generator, if necessary
	Voltammeter faulty	Replace voltammeter
With starter switched on, voltammeter shows voltage below 17 V	Terminals oxidized, or wires connected to them are loose	Clean terminals and wire lugs, and connect wires securely
	Batteries heavily discharged	Charge storage batteries

[redacted]

With engine running, and battery switch closed, voltammeter indicates (with button pressed) voltage below 26.8 V or above 30 V	Regulator faulty or out of adjustment	Check regulator, and replace it, if necessary
Electric starter fails to develop sufficient speed	Storage batteries discharged	Check voltage, and if necessary, send storage batteries for charging
Batteries are discharged rapidly	Generator fails to charge batteries	Find out and eliminate cause of trouble
	Accelerated self-discharge of batteries	Check batteries, and send for charging, if necessary
With start button pressed, starter would not be switched on	20-A safety fuse on central panel (in start button circuit) is blown	Replace safety fuse
	Wires loose or broken	Find out and eliminate trouble
	Start button faulty	Check, and, if necessary, replace button
Starter engagement is accompanied with knocking of starter gear	Flywheel rim teeth dented	Remove dents
Starter gear fails to engage or turn crankshaft	Starter improperly mounted	Mount starter properly
	Batteries discharged	Charge batteries
	Starter not reliably attached	Secure starter reliably
With engine not running, voltammeter fails to indicate battery voltage	Safety fuse in battery protection unit is blown	Find out cause of trouble, eliminate it and replace safety fuse
	Poor contact in battery terminal	Restore contact
	Wire disconnected from voltammeter	Connect wire
	Voltammeter faulty	Check and, if necessary, replace voltammeter
Generator overheats	Generator blow-off line clogged	Clean air line
One of consumers (headlight, signal lamp, horn, blower, etc.) is faulty	Safety fuse blown	Check and replace fuse
	Consumer faulty	Check and replace consumer
	Switch faulty	Check and, if necessary, replace switch
	No contact, or break in supply circuit	Check and eliminate trouble

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10. COMMUNICATION FACILITIES

10.1. GENERAL

The vehicle is equipped with external and internal communication facilities. External communication is effected with ultrashort-wave radio station P-123M, and internal communication, with tank interphone system P-124.

10.2. RADIO STATION P-123M

10.2.1. Specifications

Radio station P-123M (Fig.278) provides two-way communication with a similar radio station or with radio stations, types P-113, P-105M, P-108M, P-109M, P-114 and P-126.

Radio station P-123M is of a transceiving, ultrashort-wave, telephone, frequency-modulated type having a noise suppressor, and employing a transceiver circuit.

Communication with external parties may be effected either directly through the radio station or through control boxes A-1 and A-2 of the tank interphone system.

It provides the following modes of operation:

- simplex telephone communication when change-over from reception to transmission and vice versa is effected with the use of a breast switch;
- stand-by reception when the radio station operates for continuous reception.

The radio station has 1261 fixed operating frequencies spaced at 25 kHz in the frequenc range from 20 to 51.5 MHz. The operating frequency range is divided into frequency bands - 20-35.75 MHz and 35.75-51.5 MHz. On any frequency the radio station provides for a search-free establishment of fixed-wave communication.

Provision is made for parametric stabilization of the frequency and automatic control of the transmitter frequency.

The radio station is provided with a frequency setting mechanism which makes it possible to prepare and fix any four frequencies of the band. Change-over from one frequency t another is done by means of the fixed-frequency band selector.

When a 4-m rod antenna is used, the radio station provides reliable communication with a similar radio station on moderate terrain within a range of no less than 20 km at the speed of the vehicle movement up to 40 km/h, with the noise suppressor cut off. With the nois suppressor cut in, the range of communication does not exceed 13 km.

The radio station is intended for use with the headsets having throat microphones ЛЭМ- and low-resistance earphones TA-56M.

The ratio station is supplied from the mains. It may operate reliably, with the mains voltage fluctuating in the range from 22 to 30 V.

The current consumed by the radio station is not over:

- 9.6 A in transmission;
- 5 A in SIMPLEX reception;
- 3 A in STAND-BY reception.

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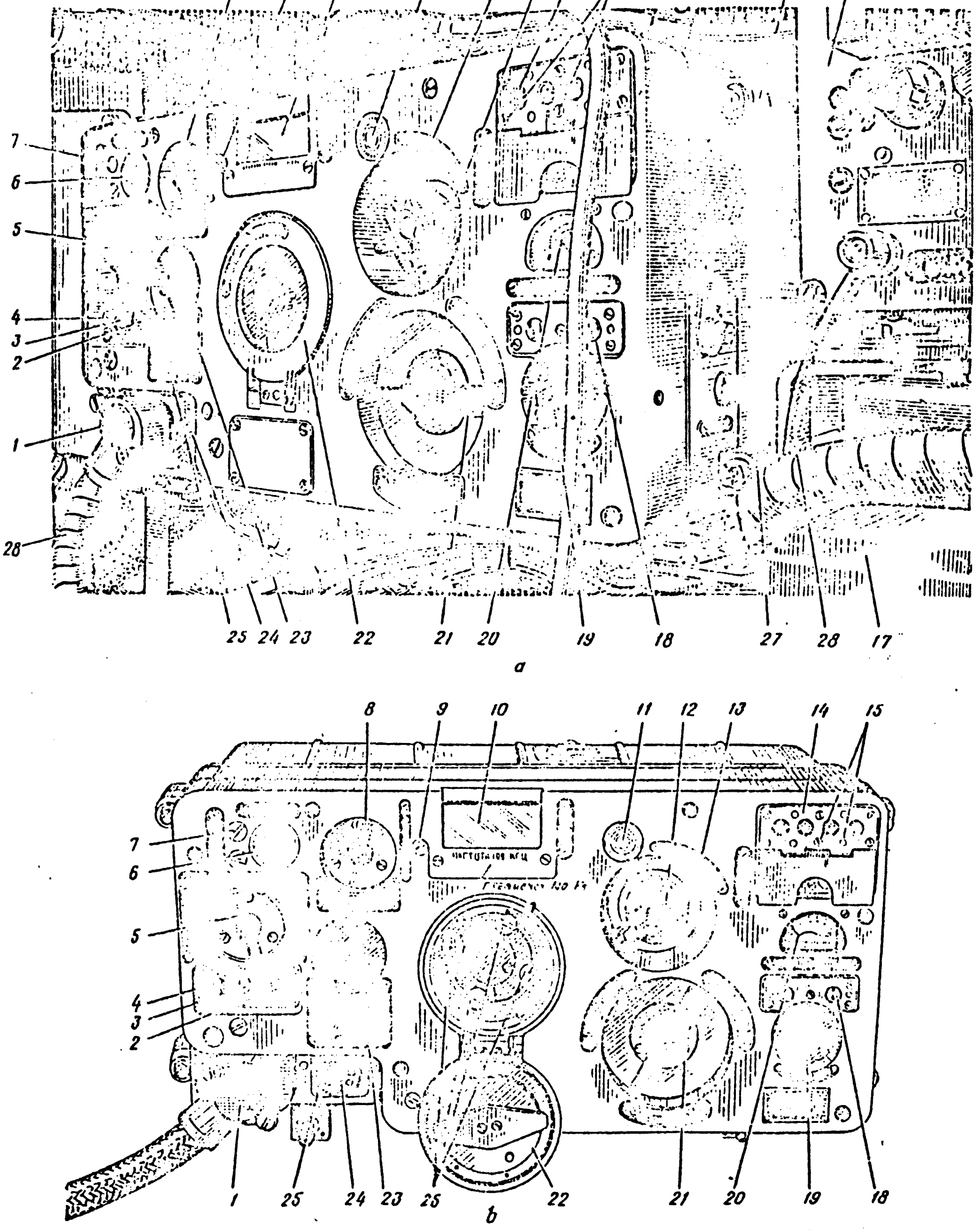

FIG.278. RADIO STATION P-123M

a - mounting of radio station on vehicle; b - radio station panel;
1 - power supply plug connector; 2 - switch POWER; 3 - button TONE-CALL; 4 - scale illumination lamp switch; 5 - switch CHECK OF VOLTAGES-OPERATION; 6 - noise suppressor control knob; 7 - frequency deviation control; 8 - function switch; 9 - frequency corrector; 10 - scale; 11 - neon turning indicator; 12 - antenna tuning knob; 13 - knob ANTENNA TUNING; 14 - fixed frequency indicating panel; 15 - fixed frequency band selectors; 16 - supply unit of radio station; 17 - tank of air-and-liquid cleaning system; 18 - band indicating panel; 19 - volume control; 20 - pointer indicator; 21 - selector FIXED FREQUENCIES-CONTINUOUS BAND; 22 - cover of fixed frequency setting lock; 23 - knob FREQUENCY SETTING; 24 - plug connector to couple interphone system P-124; 25 - plug of frequency calibrator access hole; 26 - locks of discs of drum used to set fixed frequencies; 27 - mounting bracket; 28 - supply unit-to-radio station cable

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The radio station is installed in the bay of the driving compartment to the left of the commander.

10.2.2. Construction

The radio station is noted for the following design features:

- the transceiver consists of separate units;
- the electric wiring of the basic units is done on printed-circuit plates manufactured from glass-fabric laminate and ceramics;
- the power unit employs semiconductor devices;
- the transceiver has a microscale and optical device to magnify the scale image.

The radio station set includes the following basic components:

- transceiver;
- power unit;
- antenna device;
- radio-frequency cable;
- power cable;
- SPTA set.

The transceiver is mounted on a shock-absorbing frame which is bolted to brackets welded to the hull. It consists of the following units: radio-frequency unit No.1, first oscillator unit No.2, intermediate and audio frequency unit No.3, front panel unit No.4, matching device unit No.5, motor unit No.6 and submodulator unit No.7.

The radio-frequency unit incorporates the entire radio-frequency section of the transceiver. It includes two power amplifiers, two transmitter exciters, frequency modulator, D.C. amplifier, two radio-frequency amplifiers, receiver, two first mixers, limiter and wide-band discriminator.

The components of the unit are mounted on ceramic plates on a common chassis.

The first oscillator unit includes a local oscillator and buffer amplifier and crystal calibrator.

The elements of the unit circuit are mounted on two ceramic plates and one pertinax plate.

The intermediate-frequency unit incorporates the receiver channel except for the RF amplifier, first local oscillator and first mixer, and also a mixer for automatic frequency control and narrow-band discriminator.

The unit wiring includes four printed-circuit plates. The basic components of the unit are the discriminator and IF amplifier filters.

The front panel unit consists of a panel and automatic control system. It is mounted on a steel plate. The plate bears the frequency setting mechanism and the matching device.

The front panel interconnects all the units of the radio station. It carries a power plug, plug to connect headsets, interunit connectors, monitoring instrument, volume control, four fixed-wave selectors, fixed wave indicating lamps, noise control knob, function switch, instrument switch, power switch, button TONE-CALL, scale illumination lamp switch, fixed-wave setting mechanism (automatic control system), wire-wound resistors for adjusting the intensity of currents flowing in the valve filament circuits during stand-by reception and simplex operation (they are used, while replacing the valves in the radio station).

A radio-frequency connector provided on the right side serves to couple the radio station to the antenna.

The matching device unit consists of an inductance coil, noncontact double-section variable capacitor and butterfly capacitors mounted on brass plates.

The motor unit serves to drive the frequency setting and antenna tuning mechanisms during fixed-wave communication. It represents a chassis mounting an electric motor, electromagnetic clutch, motor speed reduction gear, clutch control relay, additional resistor of the motor speed governor and spark-extinguishing filters.

The power supply is applied to the motor unit through a seven-pin receptacle provided on the chassis side; the switching circuits are also connected through this receptacle.

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done on a printed-circuit plate made from glass-fabric laminate. The output transformer is attached to the unit wall.

Each of the transceiver units is a quite independent functional unit having its own control elements and reference parameters.

The supply unit (Fig.279) of the radio station is intended to convert the direct current of the mains into a current of a high voltage (250 and 600 V) required for the radio station supply.

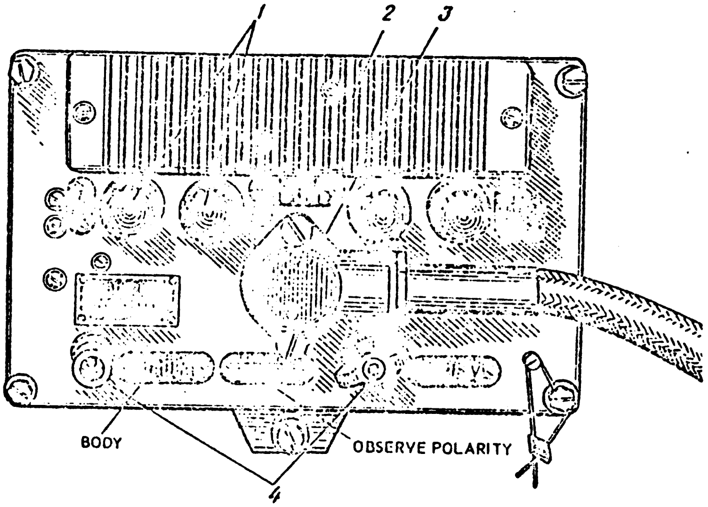

FIG.279. SUPPLY UNIT OF RADIO STATION
1 - safety fuses; 2 - cooler of stabilizer triodes; 3 - receptacle of power supply cable; 4 - terminal to connect mains wires

The supply unit consists of three converters employing semiconductor devices. Converters Nos 1 and 2 function in all the modes of the radio station operation, and convertor No.3 operates in the SIMPLEX (transmission and reception) only. Converters Nos 1 and 2 employ toroidal transformers that are wound on ferrite rings placed in steel casings, and transformer No.3 that is assembled on a steel core.

Triodes are mounted on a separate panel cast of aluminum alloy. The supply unit incorporates a switching relay intended to cut in convertor No.3 during transmission. The rectifier diodes and the stabilizer stabilitrons are mounted on a pertinax plate arranged on the upper part of the unit.

The convertors are secured on a common chassis divided into three compartments and placed in a casing.

The front panel of the unit has two terminals 4 for connecting the mains cables, four holders 1 with safety fuses, stabilizer triodes with coolers 2, and 16-pin receptacle 3 to connect the cable running from the supply unit to the transceiver.

The antenna device (Fig.280) consists of a 4-m rod antenna, upper (5) and lower (2) polyethylene insulators, spring rubber-covered shock absorber 9, metal stem 15 with fastening parts, metal holder 6 with screening sleeve 1 having radio-frequency connector 16 and protective cap 8.

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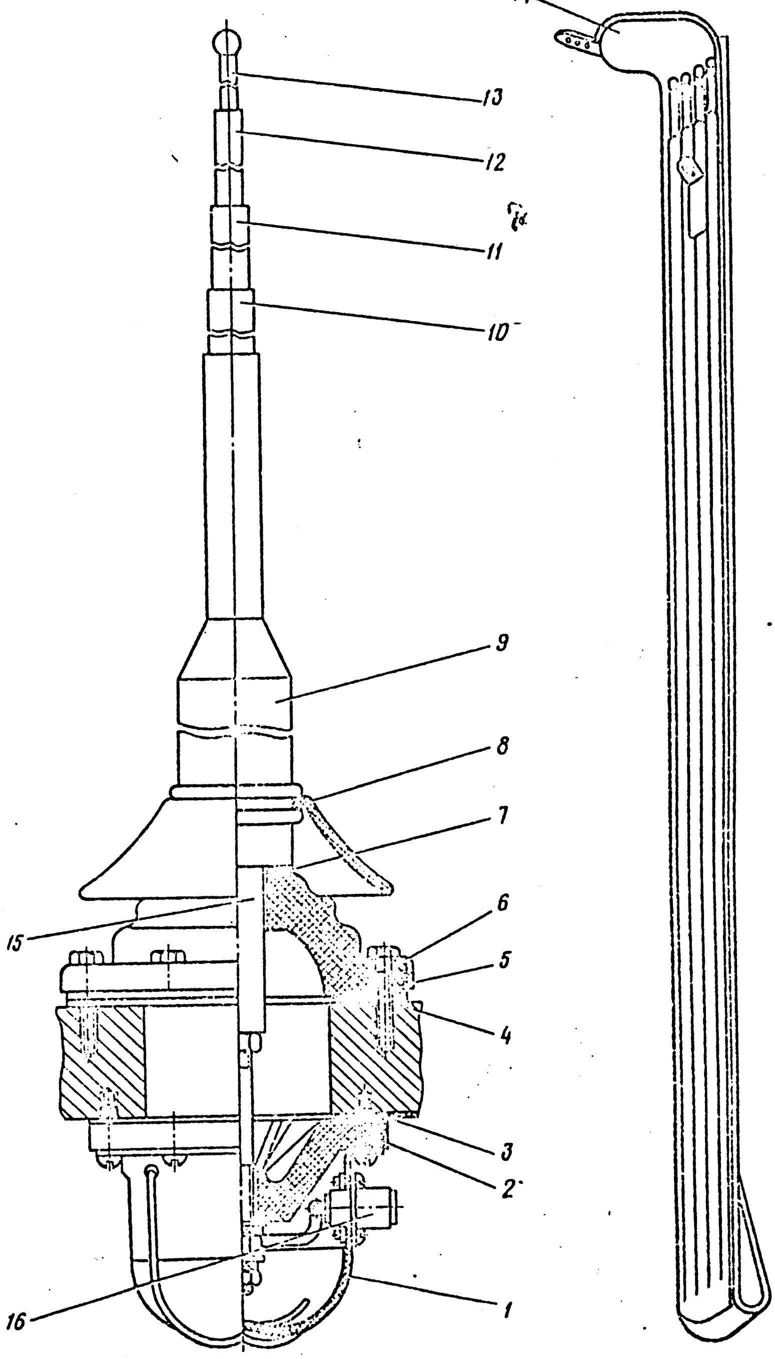

FIG. 230. ANTENNA DEVICE

1 - screen; 2 - lower insulator; 3, 4, 7 - gaskets; 5 - upper insulator; 6 - holder; 8 - cap; 9 - shock absorber; 10 - lower antenna rod; 11 - second antenna rod; 12 - third antenna rod; 13 - upper antenna rod; 14 - set of antenna rods in case; 15 - metal stem; 16 - radio-frequency connector

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Upper insulator 5 is attached to the outside of the vehicle with the help of holder 6 and six bolts. The upper insulator is protected from sunrays and atmospheric precipitation by rubber cap 8 fitted on the shock absorbers.

Lower insulator 2 is attached to the inside of the hull with the help of six bolts. Placed under the insulators are rubber gaskets 3.

The lower insulator and current-carrying parts are closed with screening sleeve 1. The plug connector of the sleeve is connected with the radio station through a radio-frequency cable.

10.2.3. Radio Station Operation

Preparing the Radio Station for Operation

Prior to preparing the radio station for operation, do the following:

- externally inspect the basic components of the radio station for reliable attachment and proper condition. Remove dust and dirt from the antenna device with dry waste (never wipe the insulators with waste soaked in kerosene, gasoline or diesel fuel);
- install the antenna having an appropriate height;
- check to see that the wires are reliably connected to terminals "+" and "-" on the supply unit of the radio station;
- remove the cover from the transceiver;
- make sure that cables connecting the supply unit with the transceiver and antenna are reliably connected;
- insert the plug of the breast switch in receptacle 24 (Fig.276) of the transceiver (P-124);
- adjust the headset on the head so that the shafts of the inner stoppers of the earphones closely adhere to the head around the ears, and the throat microphones slightly press the throat;
- insert the four-pin plug of the headset in the receptacle of the breast switch;

Set the control knobs on the front panel of the transceiver in the following positions:

- function switch 8 in position SIMPLEX (СИМПЛЕКС);
- knob NOISE (ШУМЫ) counter-clockwise as far as it will go (to the maximum noise position);
- switch TEST OF VOLTAGES-OPERATION (КОНТРОЛЬ НАПРЯЖЕНИЙ-РАБОТА) in position OPERATION (РАБОТА I);
- volume control knob 19 clockwise (to the maximum volume position);
- switch 4 SCALE (ШКАЛА) in the ON (ВКЛ.) position;
- switch 2 POWER (ПИТАНИЕ) in the ON position; before doing so, switch on the storage batteries. As a result, the illumination lamps of scale 10 and light signal panel 18 come on;
- knob 21 FIXED FREQUENCIES-CONTINUOUS BAND (ФИКСИРОВАННЫЕ ВОЛНЫ - ПЛАВНЫЙ ПОДДИАПАЗОН) in position CONTINUOUS BAND I or II.

Checking the Transceiver for Serviceability

To check the receiver of the radio station after the latter is prepared for operation, turn knob 23 FREQUENCY SETTING (УСТАНОВКА ЧАСТОТЫ), listen to the receiver throughout the entire band.

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If the receiver is serviceable, a specific noise (natural noise of the receiver) or the noise of any radio station is heard in the earphones; the natural noise of the receiver changes as volume control knob 19 is rotated.

Perform the same check in the second band.

Check the noise suppressor for serviceability by turning knob 6 NOISE. As the knob is turned clockwise, the noise level should decrease.

Check the transmitter for serviceability as follows:

- press the lever of the breast switch and set it in position TRANSMIT (ПРД). As a result, the transmitter is switched on, and a light background caused by the converters of the supply unit is heard in the earphones;
- tune the antenna by knob 13 ANTENNA TUNING (НАСТРОЙКА АНТЕННЫ) on any frequency of each band; the pointer of indicator 20 should deflect as far as possible, and neon lamp 11 must burn at full glow. Antenna tuning may require multiple rotation of knob 13 since twelve revolutions of the knob correspond to one revolution of the tuning capacitor.

Watching the pointer indicator, select the maximum value corresponding to the maximum power output of the antenna.

If the indicator pointer deflection is not sufficient, set switch 5 CHECK OF VOLTAGES - OPERATION in position OPERATION corresponding to the maximum sensitivity of the instrument;

- check the transmitter modulation over the entire range, for which purpose pronounce loudly ONE, TWO, THREE and see that those words are clearly heard in the earphones;
- check the tone call, for which purpose press button 3 TONE - CALL; see that monotone howling is heard in the earphones. Place the lever of the breast switch in the RECEIVE (ПРМ) position.

Check the fixed-frequency setting mechanism as follows:

- open round cover 22 on the front panel of the transceiver. Locks 26 of the predetermined (any) four frequencies (1, 2, 3 and 4) must be tightened up, i.e. the lock slot must be against the circular slot of the drum.

Tighten up the locks with use of a screw-driver contained in the radio station set. Do it as follows:

- close cover 22, tighten up lock 12 of knob 13 "ANTENNA TUNING, for which purpose turn it clockwise as far as it will go;
- place switch 21 FIXED FREQUENCIES - CONTINUOUS BAND in position of first fixed frequency and check the automatic mechanism for operation. Several seconds later, the electric motor must stop; at the moment it stops knobs 23 FREQUENCY SETTING and 13 ANTENNA TUNING stop turning.

Successively set switch 21 FIXED FREQUENCIES - CONTINUOUS BAND in positions of second, third and fourth fixed frequencies and check the automatic control mechanism for reliable operation.

Now, the radio station check is considered over. The radio station must be deenergized by placing switch 2 POWER in the OFF (ВЫКЛ.) position.

CAUTION: As radio station is being checked for serviceability, knob 13 ANTENNA TUNING may fail to stop rotating.

To avoid it, proceed as follows:

- switch off the radio station;
- place switch 21 against the frequency at which the tuning mechanism of the matching device fails to stop (knob 13 ANTENNA TUNING);
- release lock 12 of knob ANTENNA TUNING;
- slowly turning the knob of the matching device in one direction and slightly rocking it to the right and to the left, make the lever tooth enter the slot on the ring of the matching device which is proved by a click (setting must be done within twelve revolutions of the knob);

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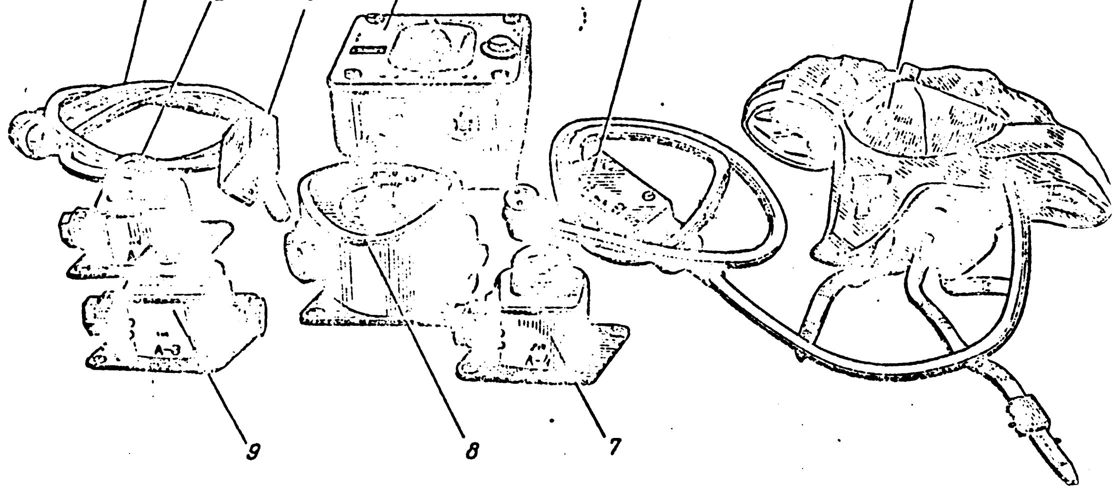

FIG. 231. TANK INTERPHONE SYSTEM (ТПУ)

1 - cable; 2 - control box A-3; 3 - breast switch; 4 - control box A-1; 5 - breast switch; 6 - headset; 7 - control box A-4; 8 - control box A-2; 9 - control box A-3

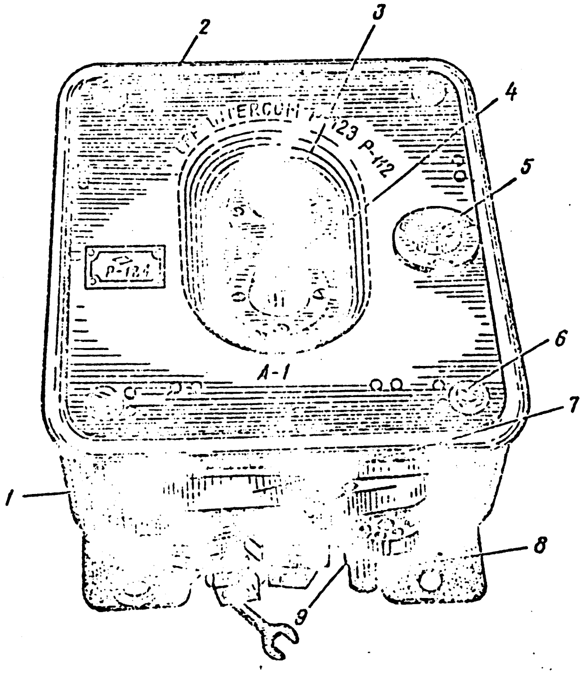

FIG. 232. CONTROL BOX A-1

1 - housing; 2 - panel; 3 - function switch knob; 4 - volume control; 5 - safety fuse holder cap; 6 - screw; 7 - receptacle; 8 - terminal; 9 - receptacle of six-contact connector

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- check the mechanism of the matching device for

switch on the radio station; knob 13 should not rotate.

To avoid the above-mentioned fault, do the following:

- see that lock 12 of knob 13 is always tightened up;
- place frequency setting switch 21 in one of the fixed positions (1, 2, 3 or 4);
- switch off the radio station only after the frequency setting and tuning mechanism of the matching device stops rotating;
- do not turn knob 13 ANTENNA TUNING, with the radio station deenergized.

Tuning the Radio Station to Four Fixed Frequencies

To tune the radio station to one of the four fixed frequencies, do the following:

- place all the controls on the front panel in positions prescribed for checking serviceability of the transceiver;
- set switch 21 FIXED FREQUENCIES - CONTINUOUS BAND to position "1" and wait till the knobs stop rotating;
- open cover 22 of the drum and release lock "I", for which purpose turn it counterclockwise so that the slot is perpendicular to the red circle;
- operating knob 23 FREQUENCY SETTING, set the necessary frequency on the scale of the radio station and then fix the lock, taking care not to disturb the frequency setting; this done, close drum cover 22;
- place switch 15 located under lamp "I" of light signal panel 14 in position BAND I or II in compliance with the predetermined communication frequency;
- set the lever of the breast switch in position TRANSMIT (ПРД);
- release the lock of knob 13 ANTENNA TUNING, for which purpose turn it to the left by two or three revolutions; use knob 13 to tune the antenna to the maximum power by the maximum deflection of the indicator pointer;
- lock knob 13, for which purpose turn lock 12 to the right as far as it will go. Check the transmitter modulation by pronouncing words ONE, TWO, THREE and make sure that they are clearly heard. Set the breast switch lever in position RECEIVE (ПРМ).

Repeat the above-mentioned operations for fixed frequencies 2, 3 and 4, and then place switch 21 against the predetermined frequency.

Setting the Radio Station Controls in Initial Position

Upon checking the radio station for serviceability and upon its tuning, make sure that all the controls occupy initial positions, namely:

- lock 12 of knob 13 ANTENNA TUNING is tightened up;
- locks 26 (1, 2, 3 and 4) of the drum discs are tightened up;
- switch 21 FIXED FREQUENCIES - CONTINUOUS BAND is in position FIXED FREQUENCIES - I;
- knob 19 VOLUME is in the maximum volume position;
- noise suppressor knob NOISE is in the extreme right-hand position;
- switch 5 CHECK OF VOLTAGES - OPERATION is in position OPERATION - I;
- function switch 8 is in position SIMPLEX;
- each switch 15 BAND is set against predetermined fixed frequency;
- switch SCALE is in the OFF position;
- switch 2 POWER is in the OFF position;

The access hole of the transceiver front panel must be closed, and the transceiver and supply unit should be closed with covers.

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bear in mind that each word pronounced by the operator is transmitted into the atmosphere. During communication strictly follow the given communication scheme. The radio exchange must be distinct and short.

While conducting communication over the maximum distance, set noise suppressor knob 6 to partial noise suppression at which communication is possible.

Immediately after the transmission is completed, place the breast switch lever in position RECEIVE so as not to disturb communication in the given radio network.

While conducting communication over short distances, it is recommended to use short antennas in order to minimize mutual interference.

To provide simplex operation of the radio station, proceed as follows:

- place function switch 8 in position SIMPLEX;
- place switch 21 FIXED FREQUENCIES - CONTINUOUS BAND against the predetermined fixed frequency;
- energize the radio station and begin operation 5-10 min later in summer, and 15-20 min later in winter;
- set the noise level by noise suppression knob 6 and the volume by knob 19 VOLUME.

In the simplex mode provision is made for sending a tone call signal to the other party. For this purpose, shift the breast switch lever to position TRANSMIT and press button 3 TONE-CALL on the front panel of the radio station. The tone call must be heard in the earphones.

Upon sending a tone call signal, release the breast switch lever and button 3 TONE-CALL.

To ensure stand-by reception, proceed as follows:

- prepare and tune the radio station for simplex operation;
- set function switch 8 in position STAND-BY RECEPTION (ДЕЖУРНЫЙ ПРИЕМ). In this case, transmission is impossible.

To answer the other party, set function switch 8 in position SIMPLEX and 2-3 min later change over to transmission.

Continuous simplex operation may be permitted only when the ratio of transmission time to reception time is 1:3, i.e. transmission for 2-3 minutes is followed by reception for 6-9 minutes. Continuous transmission for longer than 10 min is not allowed so as not to cause transceiver overheating.

Duration of stand-by reception is not limited.

10.2.4. Safety Measures To Be Observed during Radio Station Operation

During radio station operation the voltage in separate circuits reaches 600 and 250 V; therefore, it is not allowed:

- to open the transceiver and supply unit while in operation;
- to touch current-carrying parts of the antenna during transmission; the lower insulator must always be closed with a protective cap;
- to install and replace the antenna, with the radio station energized and during transmission.

10.3. TANK INTERPHONE SYSTEM (ТПУ)

10.3.1. Purpose and Components

Interphone system P-124 (Fig.281) ensures internal telephone communication between five parties (three crew members and two troopers) in the vehicle.

The interphone system provides the following kinds of communication:

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between five parties;

- conference telephone communication between all the parties;
- external communication by radio through control boxes A-1, and A-2 connected radio station P-123M.

When the commander (operator) is involved in external communication, all the o parties may maintain internal communication.

The interphone system is an amplifying-switching set consisting of control box control box A-2, two control boxes A-3, control box A-4, six breast switches, and h with throat microphones.

All the headsets are interchangeable, they may be connected to any control box interphone system.

10.3.2. Control Box A-1

Control box A-1 (Fig.282) provides internal communication between the commander all the parties, as well as external communication.

It consists of front panel 2, switching device, final amplifier, throat micropho amplifier unit, chassis, housing 1 and bracket with shock absorber.

The face side of front panel 2 carries knob 3 of the function switch, volume co rol 4 and safety fuse holder cap 5. The chassis attached to the inner side of the pa mounts a switching device, final amplifier and throat microphone amplifier unit.

Arranged on the lower portion of housing 1 are: receptacle 7 for connecting the running from the radio station and from control box A-2, receptacle 9 of the six-conta plug connector for connecting the breast switch, and terminal 8 for connecting the plu of the vehicle mains. Located inside the control box is a contact panel.

The switching device permits all kinds of communication. Change-over from one kin communication to another is effected with the use of the two-pancake switch of control A-1 and breast switch. The switch of control box A-1 has four positions: OFF (ВЫКЛ.), INTERCOM (ВС), P-123 (radio station P-123M ON) and P-112 (radio station P-112 ON).

The switching device incorporates a relay which changes over the earphones and thr microphones from external communication to internal communication. To effect such a change-over, any party should press the lever of the breast switch to position CALL (ВЫ

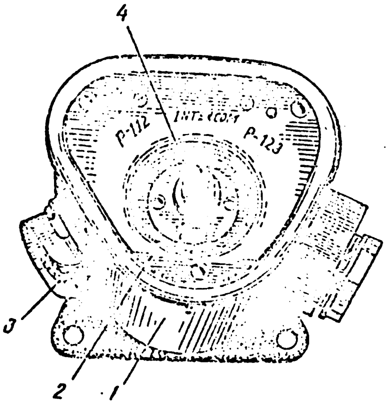

FIG.283. CONTROL BOX A-2

1 - housing; 2 - panel; 3 - receptacle; 4 - function switch knob

The throat microphone amplifier is designed for amplification of the speaking voltage (produced by el magnetic throat microphones ЛЭМ-3 from 3 mV to about It consists of two stages employing a common-emitter circuit with three semiconductor triodes.

The final amplifier amplifies the power of the sp ing currents passing from the throat microphone amplif of all the parties.

The audio-frequency voltage amplified by the fina amplifier is applied to the earphones.

The final amplifier has two amplification stages; stage employs a common-emitter circuit with a germaniu triode, and the other stage employs a common-emitter push-pull circuit with two power triodes.

The input transformer of the final amplifier circu serves to match the output resistance of the throat microphone amplifiers with the input resistance of the first amplifier stage triode.

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Control box A-2 (Fig.283) provides internal communication with other parties, and external communication.

It consists of two components:

- front panel 2, carrying the switching device and throat microphone amplifier;
- housing 1 incorporating terminals for connecting cables and receptacle 3 of the six-contact plug connector to connect the breast switch.

The circuit and operating principle of the throat microphone amplifier are the same as in control box A-1.

The switching device is, in fact, a two-pancake switch having three positions: P-112, INTERCOM and P-123. Knob 4 of the function switch is on the front panel.

10.3.4. Control Boxes A-3 and A-4

Control boxes A-3 and A-4 (Fig.284) serve for internal communication between the driver and two troopers.

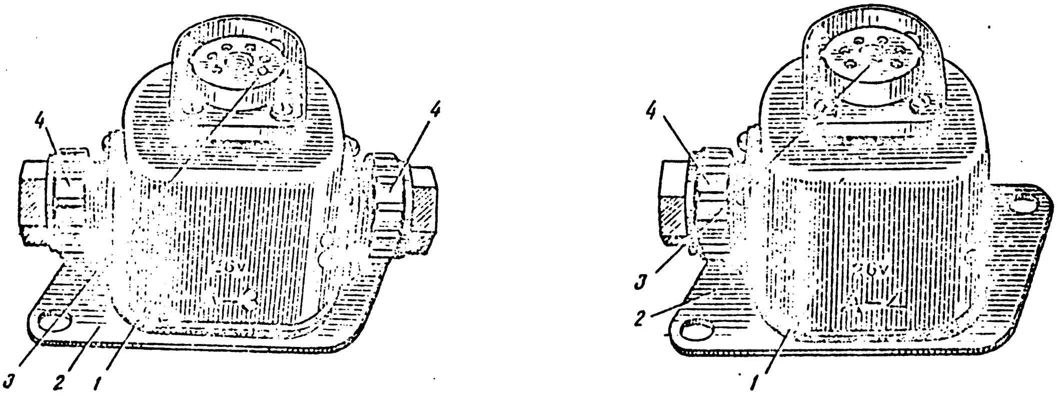

FIG.284. CONTROL BOXES A-3 AND A-4

1 - housing; 2 - base; 3 - receptacle of six-contact connector; 4 - terminal for connecting cables

Control boxes A-3 and A-4 are similar in design. They consist of housing 1 and base 2. The base has two holes for bolts securing the control box to the bosses on the vehicle hull.

Each control box incorporates a throat microphone amplifier having a terminal strip to connect the conductors of the cables and the wires running from the six-contact receptacle. The housing of each control box has six-contact receptacle 3 to connect the breast switches, and terminals 4 to connect the cables.

10.3.5. Breast Switch

The breast switch serves for change-over from reception to transmission and vice versa and also to conference call.

It represents a flat plastic case; one end of the latter holds a six-conductor rubber-covered cord, and the other end, a four-contact half-connector.

A lever built in the switch side has three positions: RECEIVE, TRANSMIT and CALL; position RECEIVE is fixed, and two other positions are non-fixed. In each position the lever closes

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tercommunication in position

communication, radio reception is possible.

When any breast switch is in the CALL position, the parties involved in external communication are automatically changed over to intercommunication.

In the TRANSMIT position, the parties connected to control boxes A-1 and A-2 can participate in external communication.

10.3.6. Headset

The headset protects the ears from foreign acoustic noise and the head from injuries. The headset has two electromagnetic throat microphones ЛЭМ-3 and two low-resistance earphones ТА-56М and a cord with a four-pin plug.

The throat microphone serves to transform mechanical oscillations of the vocal chords into audio-frequency electric oscillations. The throat microphone represents a plastic case incorporating a core with two coils, and a diaphragm. During the talk the oscillations of the vocal chords make the diaphragm deflect; as a result, the diaphragm changes the magnetic field of the core, thus inducing currents in the coil winding; the currents are amplified in the control boxes by the throat microphone amplifiers.

The earphones convert the audio-frequency electric oscillations into sound waves.

10.4. CARE OF COMMUNICATION FACILITIES

Care of the radio station includes:

- inspection, checking the position of the control knobs (they must be in initial position);
- checking the radio station and supply unit for secure attachment, and the cables for reliable connection;
- checking the antenna, insulators, headsets and breast switches for condition.

Besides, the care includes cleaning the control boxes, transceiver, supply unit and antenna device from dust and dirt and closing them with covers (when they are not used).

10.5. TROUBLES AND REMEDIES

Trouble	Cause	Remedy
	Radio Station Р-123М	
With switch POWER SUPPLY closed, band indication and scale illumination lamps are dark	Ground switch open Safety fuse on distribution board blown	Close ground switch Replace safety fuse
Frequency setting mechanism fails to operate No mains voltage	No contact in supply cable connectors Safety fuse Пр8-3 in supply unit blown	Tighten up connector screws Replace safety 8-A fuse (second as counting from left
One of lamps of signal light panel or scale illumination lamp is dark	Lamp burnt out	Replace lamp
When changed over to any fixed frequency, electric motor keeps on running (knob ANTENNA TUNING rotates)	Locks on drum of automatic control mechanism or antenna tuning lock not tightened	Tighten up locks, set automat control mechanism in proper position as pointed out in Subsection 10.2.3.
Receiver is faulty (no noise is heard) and no self-monitoring is provided, though	Earphone circuit in headset faulty Breast switch faulty or	Check headset through interphone system, and replace it, i necessary

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supply voltages are fed from supply unit, and antenna current is present	poorly secured in connector	Replace or securely fasten breast switch
	Control box of interphone system P-124 faulty	Connect breast switch directly to radio station and check its operation
Receiver is faulty (no noise), no self-monitoring is provided, and supply voltages (+150 V, +1.2 V, +6.3 V) are not fed to receiver	Пр8-2 safety fuse blown	Replace safety fuse (first, as counting from left)
No antenna current, though self-monitoring is provided	8-A safety fuse Пр8-1 or 0.5-A safety fuse Пр8-4 faulty	Check supply voltages +600 V and +250 V; if these voltages are absent, replace safety fuses (second or first, as counting from right) on front panel of supply unit
No antenna current. No supply voltages +600 V and +250 V though self-monitoring is provided	Safety fuse Пр8-1 blown	Replace 8-A safety fuse (second, as counting from right)
	Safety fuse Пр8-4 blown	Replace 0.5-A safety fuse (first, as counting from right)
No antenna current in one of bands, though it is present in other band; self-monitoring is provided in both bands	One of valves ГУ-50 (Л1 or Л1-2) faulty	Replace valve ГУ-50
In mode SIMPLEX - TRANSMISSION self-monitoring is not provided, receiver noise is normal, antenna current is present, voltage is fed from supply unit	Throat microphone circuit in headset faulty	Check headset through interphone system, and replace, if necessary
	Breast switch faulty or poorly secured in connector	Replace or securely fasten breast switch
	Control box of interphone system faulty	Connect breast switch directly to radio station and check operation
Radio station would not change over for simplex operation	Breast switch faulty	Replace breast switch
No communication between parties, self-monitoring is provided; neon lamp glows (often very brightly); readings of pointer indicating instrument either increase (pointer overshoots) or decrease	Antenna circuit proves to be faulty	Use knob ANTENNA TUNING to tune the transmitter. If during fine tuning neon lamp glows very brightly and indicating instrument pointer overshoots (in both positions of change-over switch VOLTAGE CHECK - OPERATION) it shows that the antenna circuit is faulty
	Antenna (all four sections) knocked down	Connect emergency antenna if no standard one is available
	Antenna cable broken	Repair
	Radio-frequency cable connecting tranceiver with antenna is broken	Replace radio-frequency cable

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Trouble		
No communication between parties, with radio station functioning normally in reception and transmission	Matching device poorly tuned	Check and tune, if necessar
	Interphone System P-124	
As function switch on control box A-1 is placed in one of operating positions, no intercommunication is provided between parties	Safety fuse of control box A-1 blown	Replace safety fuse
	Function switch of control box A-1 or interphone system supply circuit faulty	See if there is supply voltage between body and terminal "+26 V" of control box A-1. If voltage is abse wiring proves to be faulty. If voltage is present, contr box A-1 proves to be faulty. Check the faulty control box and, if necessary, send it for repair
	Filter of control box A-1 faulty	Send faulty control box fo repair
One of parties does not hear the other party through all channels	Earphone circuits in headset of given party or in cord of his breast switch are broken	Replace headset; if party he other party, replaced headse proves to be faulty. If party does not hear other party upon replacement of headset, breast switch prove to be faulty. Replace breast switch
	Function switch of control box A-1 or A-2 faulty	Send control box for repai
One of parties does not hear other party through one channel	Function switch of control box faulty	Check and, if necessary, for repair
	Relay of control box A-1 faulty	Send faulty control box fo repair
Speech of one of parties is not heard over intercommunication circuit	Throat microphone circuit in headset of given party or in cord of his breast switch is broken or shorted	Replace headset. If speec given party is heard, replac headset proves to be faulty no speech is heard, breast switch proves to be faulty
	Throat microphone amplifier faulty	Replace throat microphone amplifier (have it done by radio technician)
No modulation of one of radio transmitters, while parties try to establish external communication through given radio station	Throat microphone circuits in headset of given party or cord of his breast switch are broken or shorted	Replace headset. If trans ter modulation is heard, re ed headset proves to be fau If no modulation is heard, replace breast switch
	Function switch of control box faulty	Check throat microphone circuits passing through br switch. Eliminate fault (ha it done by technician)

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Transmitter of radio station would not be put in operation when party connected to control box A-1 or A-2, sets lever of his breast switch in position TRANSMIT	Breast switch contacts faulty	Replace breast switch
Conference communication is not provided when one of parties sets lever of his breast switch in position CALL	Contacts or cord of breast switch of given party faulty	Replace breast switch
	Relay of control box A-1 faulty	Send faulty control box A-1 for repair

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11. ABC PROTECTION AND CREW LIFE SUPPORT SYSTEM

11.1. GENERAL

The ABC protection and crew life support system is intended for protection of the crew, troopers and equipment from the mass annihilation weapons and for ventilation of the personnel compartments.

For the arrangement of the above system, see Fig.285.

Protection against the shock wave is ensured by sealing the hull and turret of the vehicle. Some sealing devices are permanently installed, and some are closed when the vehicle enters a dangerous zone. Owing to hull sealing, the rate of pressure rise inside the vehicle is decreased, and consequently the pressure value is reduced.

Protection against radioactive dust is ensured by building up an excessive pressure inside the vehicle; an excessive pressure prevents penetration of air with dust inside the vehicle.

The air coming inside the vehicle is purified with filter-ventilating unit (ФВУ).

The vehicle armour gives protection against radioactive radiation.

The ABC protection and crew life support system includes: filter-ventilating unit with air heating and distribution system, exhaust ventilation system, sealing assemblies, actuating mechanisms, and electrical equipment.

11.2. FILTER-VENTILATING UNIT

The filter-ventilating unit is intended to clean the air of dust, radiological, chemical and bacteriological warfare agents and supply it inside the vehicle. It also serves to built up an excess pressure inside the vehicle. The filter-ventilating unit may be used for ventilation only or for ventilation and filtration simultaneously.

The filter-ventilating unit includes special blower 34, valve box 32, absorbent filter 29 and duct 19 for supplying the pure air to the personnel compartments.

The special blower and the absorbent filter are connected by the valve box and located in a separate compartment on the left side of the vehicle (behind the commander).

Special Blower

The special blower (Fig.286) serves to clean the air of dust, to supply it to the personnel compartments, and build up an excess pressure inside the vehicle. The air is cleaned of dust due to centrifugal forces produced by the blower. The blower consists of housing 12 with cover 14 and screen filter 16, electric motor 11, impeller 21 with guide vane assembly 17 and screen 13.

Impeller 21 is assembled of 160 longitudinal blades that form narrow channels along the body. The guide vane assembly consisting of forty vanes is designed to reduce the hydraulic losses at the inlet and thus to increase the efficiency of the blower. The impeller and the guide vane assembly are fitted on a common bushing which is secured on shaft 19 of the

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The rotating impeller forces the air to swirl and thus to throw the dust particles to peripheral separator 20 which represents a thin-walled cylinder having narrow slots. The dust passes through the slots into the space between the separator and the body and, thence, to dust collector 22; after that, the dust is discharged via pipeline 15 into hollow beam of the vehicle hull and then into the pocket of the engine compartment bulkhead from which it is taken by the air cleaner. Air is sucked into the special blower through an end port closed by screen 16 from the tight compartment of the filter-ventilating unit which communicates with the circular air duct of the engine air supply system through a square channel.

The special blower purifies the air of dust by approximately 98%.

The valve box is intended to control the direction of the air stream coming out of the blower.

It consists of a body connected to the special blower housing, with the absorbent filter casing and with hollow support by branch pipes; valve 3 and valve control mechanism.

Disc valve 5 (Fig.287) is secured by a pin to the end of lever 3 which is fitted on axle 2. The lower end of axle 2 carries lever 41 which is connected with rod 37 of electromagnet 36 through manual control cable 42 and latch 35. Valve 5 may be in two positions: either it closes the inlet port of the absorbent filter and lever 41 is connected with the rod of electromagnet 36 through latch 35 or, with the electromagnet operating, latch 35 is disengaged from lever 41, and valve 5 opens the inlet port of the absorbent filter and closes the port in hollow support 1 of the filter under the action of spring 4.

At this moment, signal lamp 40 ФПТ VALVE OPEN starts glowing since lever 41 actuates limit switch 34 of the signal lamp circuit.

The valve of absorbent filter ФПТ may be closed by the manual control linkage only. For this purpose pull cable 42 by handle 39.

Absorbent filter ФПТ-200М serves to clean the air of chemical agents and bacteriological and radioactive aerosols. It is attached to hollow support 1 of the filter with two bands 21.

The filter consists of cylindrical casing 22, central cylinder 28 with flanges 26, smoke filter 29, smaller perforated cylinder 30 and larger perforated cylinder 31, absorber 24, shock absorbing pad 25 and a bottom.

The smoke filter having a variable-length fold is assembled on the flanges of the central cylinder by means of collars and sealed with latex.

The absorber is poured into the concentric space between the perforated cylinders and closed with a cover having a shock-absorbing pad.

The filter functions as follows.

With valve 5 opened, contaminated air enters the inlet port of the absorbent filter and passes over branch pipe 43 to central cylinder 28; then it flows through smoke filter 29 where it is purified of fine dispersed aerosols and fine dust; then, the air passes through absorber 24 which absorbs the vapours of chemical agents and escapes through the outlet port in the side surface of casing 22. The air coming out of the outlet port enters hollow support 1 and passes over branch pipe 44 to heater housing 19. From the latter the air is delivered over distributing pipelines to the driving compartment, and to the right-hand and left-hand sections of the troop compartment.

Each of the pipelines running to the troop compartment has four tubular adapters with nozzles through which the purified air is supplied to the troopers. The pipeline running to the driving compartment has two adaptors through which the purified air is supplied to the commander and driver. The nozzles are freely fitted on the ball supports owing to which they can easily turn and change the direction of the air jet.

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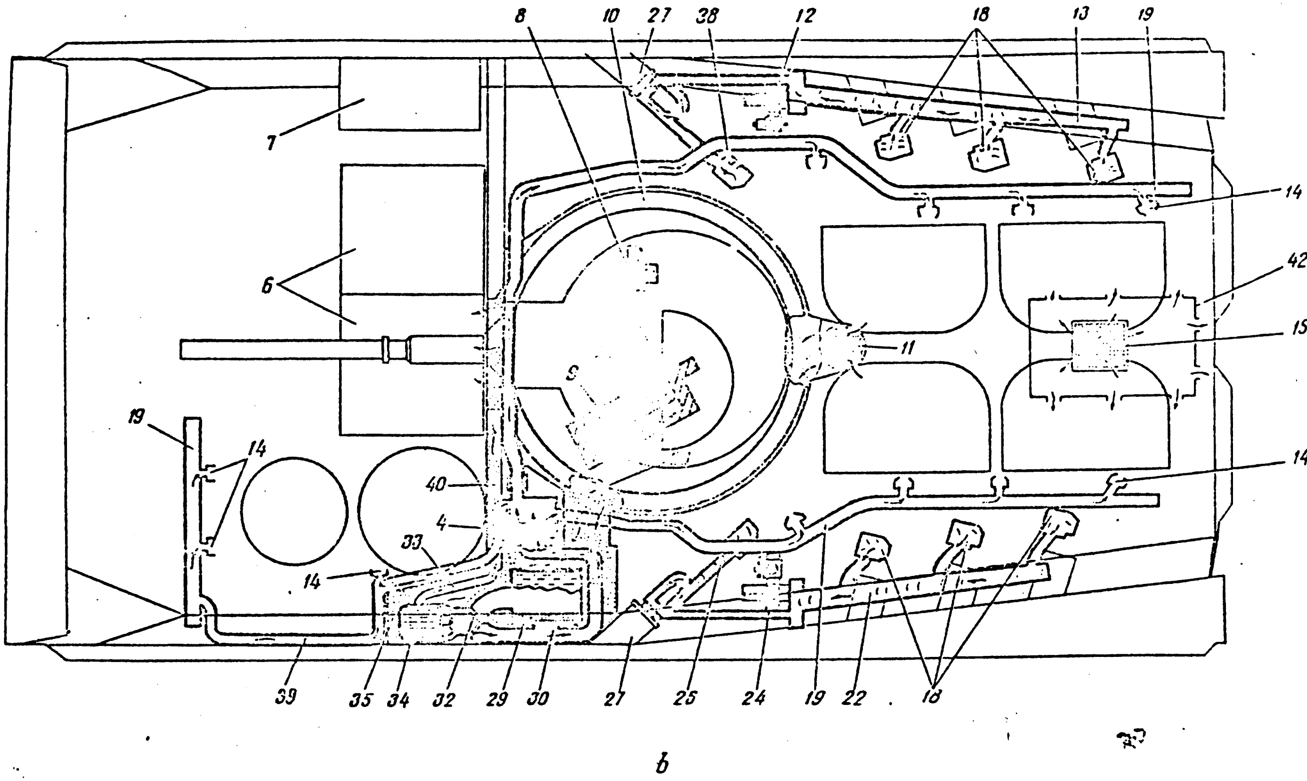

FIG.285. DIAGRAM OF ABC PROTECTION AND CREW LIFE SUPPORT SYSTEM

1 - adapters of air pipelines running from special blower and absorbent filter; 2 - engine shut-down mechanism; 3 - ejector louvres and shutters control linkage; 4 - heater of filter-ventilating unit; 5 - commander's hatch cover; 6 - louvres of cooling system; 7 - ejector shutters; 8 - turret exhaust blower; 9 - pipelines to discharge gases from empty case-and-link collector; 10 - annular air duct; 11 - air intake pipe; 12 - exhaust blower; 13 - main of exhaust ventilation system; 14 - adapters of pipelines running from special blower; 15 - troop compartment heater; 16 - ball support for submachine gun; 17 - submachine gun; 18 - submachine gun empty case deflectors; 19 - air main running from special blower; 20 - ball support for submachine gun; 21 - firing port cover; 22 - main of exhaust ventilation system; 23 - machine gun ПК; 24 - L.H. exhaust blower; 25 - machine gun support; 26 - powder gas suction pipe; 27 - ball support for machine gun ПК; 28 - main to connect annular air duct with filter-ventilating unit; 29 - absorbent filter; 30 - hollow support of absorbent filter; 31 - fender; 32 - valve box of filter-ventilating unit; 33 - branch pipe to discharge dust from special blower into annular air duct; 34 - special blower of filter-ventilating unit; 35 - filter-ventilating unit compartment; 36 - adapters of air pipeline running from special blower; 37 - driver's hatch cover; 38 - empty case-catch of machine gun ПК; 39 - pipeline; 40 - hollow beam to discharge dust from dust collector of special blower; 41 - empty case-and-link collector; 42 - battery compartment

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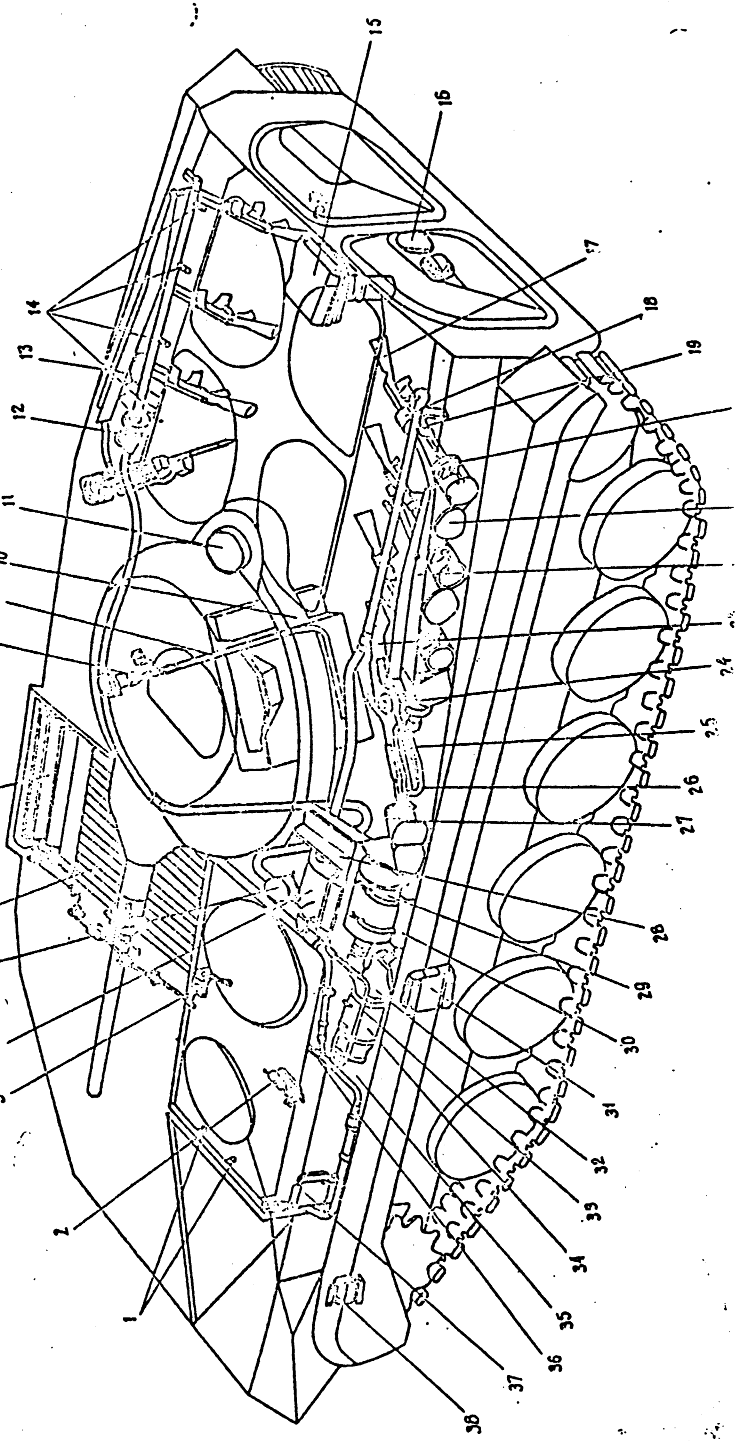

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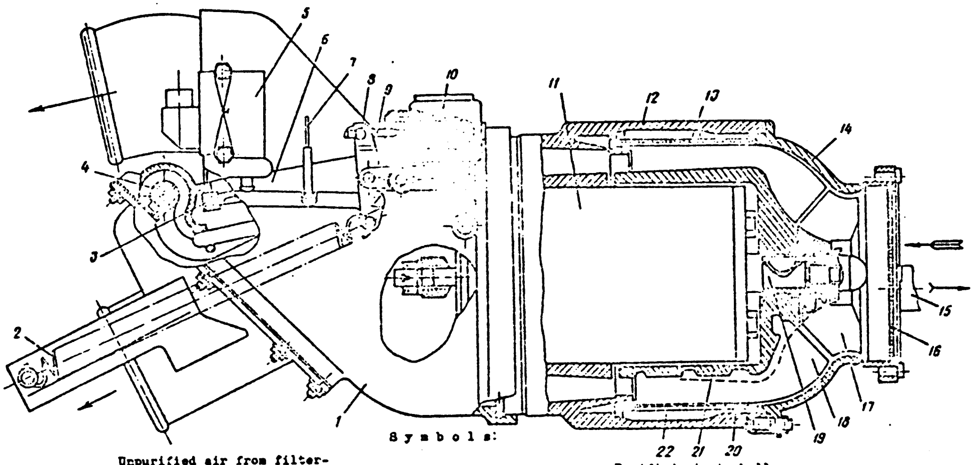

Symbols:

Unpurified air from filter-ventilating unit compartment

Purified air to absorbent filter

Purified air to hollow support of filter-ventilating unit

Dust

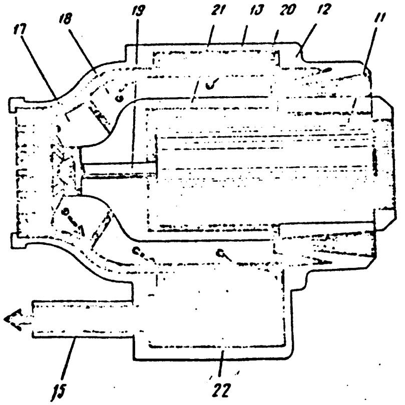

FIG.286. DIAGRAM OF SPECIAL BLOWER WITH VALVE BOX

1 - valve box; 2 - spring; 3 - valve; 4 - axle; 5 - limit switch; 6 - lever; 7 - cable; 8 - lock; 9 - electromagnet rod; 10 - electromagnet (PM-1); 11 - electric motor; 12 - special blower housing; 13 - screen; 14 - housing cover; 15 - pipeline to discharge dust from special blower; 16 - screen; 17 - guide vane assembly; 18 - blower blades; 19 - motor shaft; 20 - separator; 21 - blower rotor; 22 - separator dust collector

vehicle.

The system consists of three blowers 8, 12 and 24 (Fig.285) one of which is arranged in the turret, and two blowers, in the right-hand and left-hand bays of the troop compartment. The system also includes air pipelines, valve boxes, electromagnets and limit switches.

All the blowers are similar in design.

The exhaust blower with valve box (Fig.288) is designed for evacuation of powder gases from the vehicle. The blower set includes electric motor 1, volute-shaped housing 15, blower 13, casing 2 connecting the blower housing with valve box 12 (the blowers of the troop compartment have no casing 2), compensator 14 which connects the air main to the blower housing, and the valve box.

The inlet port of the turret blower is provided with a branch pipe with divider instead of the compensator which serves for sucking the gases from the fighting compartment and the empty case-and-link collector.

Housing 15 of the blower mounted on the turret is attached to casing 2 with four bolts, and casing 2 is screwed to valve box 12 which is flange-connected to the turret roof.

A mushroom welded to the turret roof over the valve box throat has a gas discharge slot.

The housings of the troop compartment blowers are fastened directly to the valve box. A visor welded to the vehicle roof against the valve box throat has a gas discharge slot directed towards the vehicle rear.

Blower 13 representing a two-disc blade wheel is fitted on the end of the shaft of the armature of electric motor 1 which is attached with four bolts 16 to blower housing 15. The volute of the blower housing is attached by its end face to the hollow longitudinal beam of the roof, serving as the air duct, with the help of compensator 14. The beam has four branches which are connected through corrugated rubber hoses with the АКМ submachine gun empty case deflectors and empty case-and-link collectors of the ПК machine guns.

The valve boxes of all the blowers are similar.

The valve box consists of the body of valve 10, valve spring 11, push rod 3 fitted with handle 6 on common axle 18, latch 8 with spring 19, electromagnet 9 (ЕП-1) and limit switch with rod 4.

The valve is opened by turning handle 6 counter-clockwise. Push rod 3 which turns together with the handle, presses stop 5 which is screwed on the stem of valve 10. When the upper face of handle 6 moves off the tooth of lock 8, the latter snaps behind handle 6 and fixes it under the action of spring 19. The handle flange presses limit switch rod 4 and starts electric motor 1 of exhaust blower 13.

The valve is closed either manually by turning lock 8, or by switching on electromagnet 9 whose armature is connected with lock 8 by means of a pin. As lock 8 is pulled, valve 10 closes under the action of spring 11, and the limit switch opens the blower circuit.

11.4. AIR HEATING SYSTEM

The air heating system consists of two heaters one of which is arranged in the duct of the filter-ventilating unit, and the other, in the troop compartment (battery compartment).

The heater of the filter-ventilating unit serves to heat the air supplied by the blower. The heater is mounted in special detachable housing 19 (Fig.287) which is bolted to the housing of the filter-ventilating unit.

It represents fin-and-tube radiator 18 to which the hot liquid is delivered from the engine cooling system. The radiator is secured inside the casing by means of bands.
Non-return valve 15 mounted in inlet branch pipe 44 of the heater prevents back flow of air through the filter-ventilating unit, with the blower being idle.

The valve is opened by the air jet and closes under gravity.

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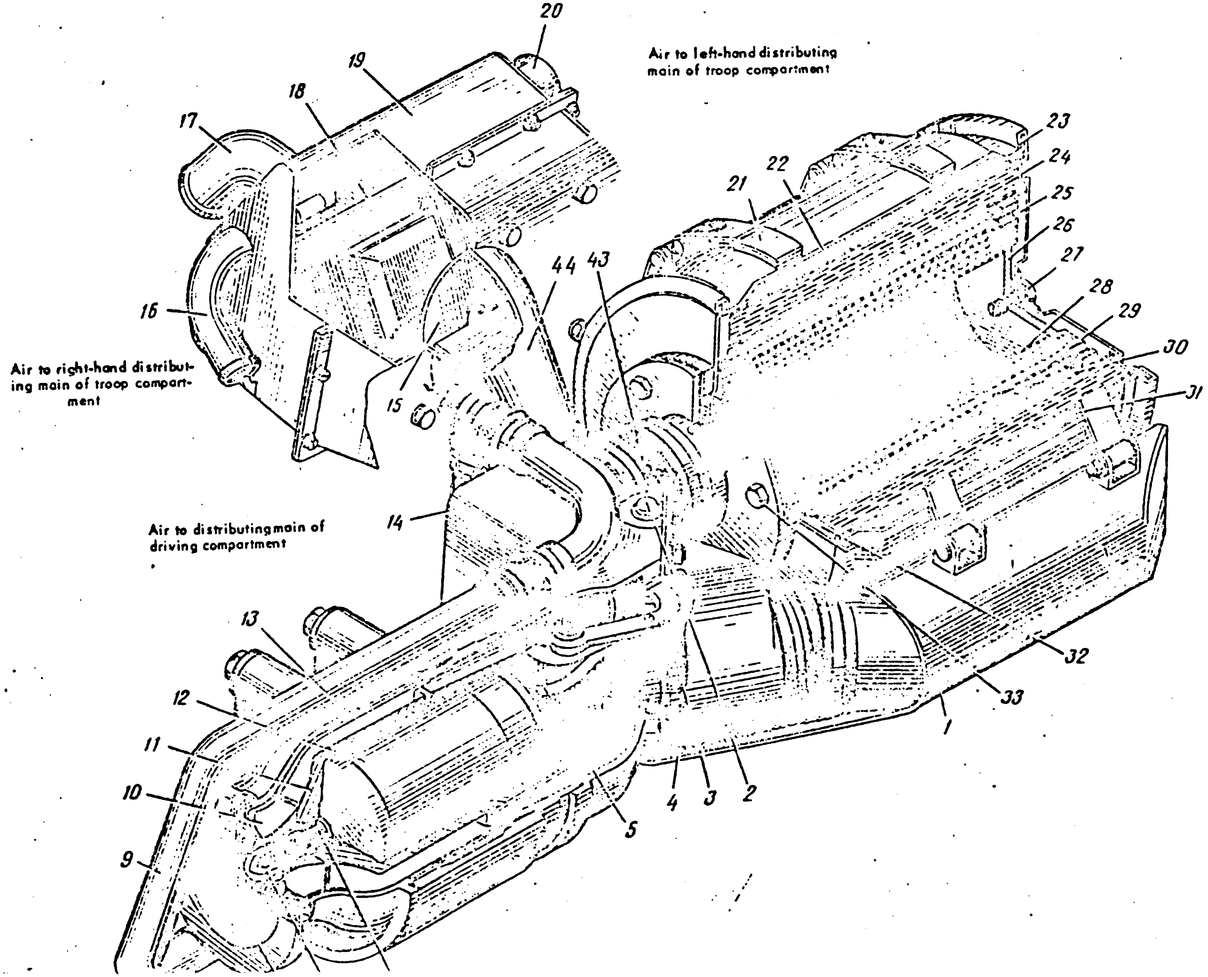
20
Air to left-hand distributing main of troop compartment
19
18
17
23
22
24
21
25
26
44
43
27
28
16
29
30
Air to right-hand distributing main of troop compartment
15
31
14
Air to distributing main of driving compartment
13
12
32
33
1
11
2
3
4
10
5
9

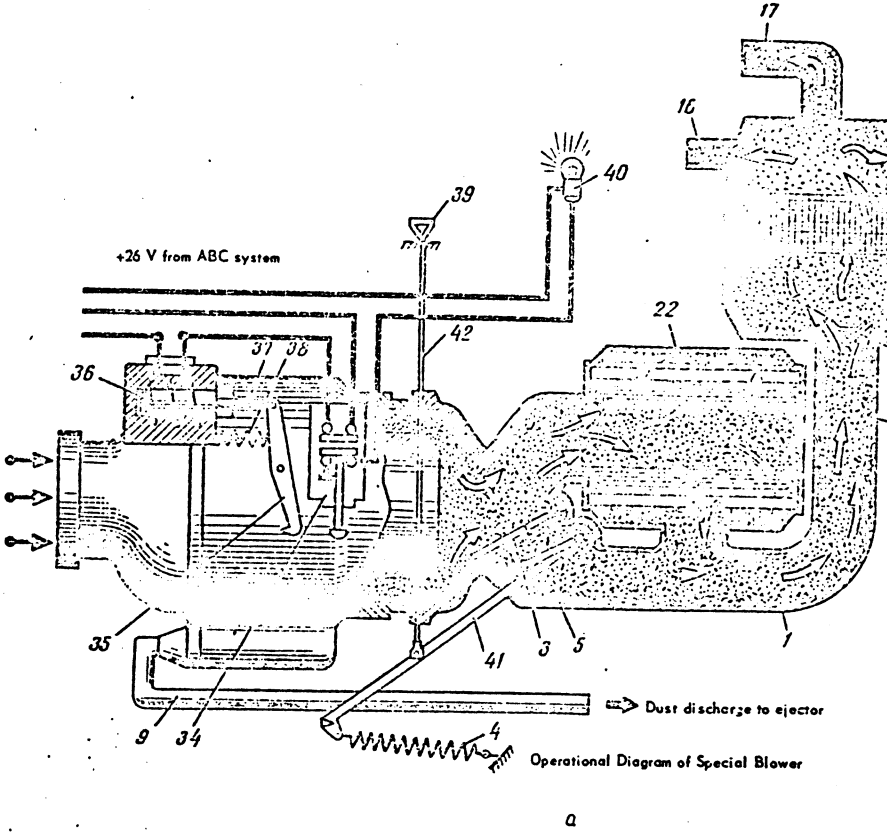
17
16
20
18
19
40
39
+26 V from ABC system
22
42
15
36
37
38
44
35
41
3
5
1
9
34
4
Dust discharge to ejector
Operational Diagram of Special Blower
a

FIG. 237. FILTER-VENTILATING UNIT (ФВУ). GENERAL VIEW

1 - hollow support of filter-ventilating unit; 2 - valve lever axle; 3 - valve lever; 4 - valve return spring; 5 - valve; 6 - motor shaft; 7 - nut to secure rotor and guide vane assembly; 8 - inlet port screen; 9 - pipeline to discharge dust from special blower; 10 - guide vane assembly; 11 - blower rotor; 12 - electric motor; 13 - separator; 14 - valve box; 15 - non-return valve; 16 - pipeline to supply air to driving compartment; 17 - pipeline to supply air to right-hand section of troop compartment; 18 - heater radiator; 19 - heater housing; 20 - pipeline to supply air to left-hand section of troop compartment; 21 - absorbent filter securing band; 22 - absorbent filter casing; 23 - rolled-up washer; 24 - absorber; 25 - shock-absorbing pad; 26 - filter element flange; 27 - filter element securing bolt; 28 - central cylinder; 29 - smoke filter; 30 - smaller perforated cylinder; 31 - larger perforated cylinder; 32 - cover; 33 - cover securing bolt; 34 - limit switch; 35 - lever latch; 36 - tractive electromagnet; 37 - armature rod; 38 - electromagnet spring; 39 - valve control cable handle; 40 - signal lamp ФПТ VALVE OPEN on the central panel; 41 - lower lever; 42 - manual control cable; 43 - inlet branch pipe of absorbent filter; 44 - inlet branch pipe of heater

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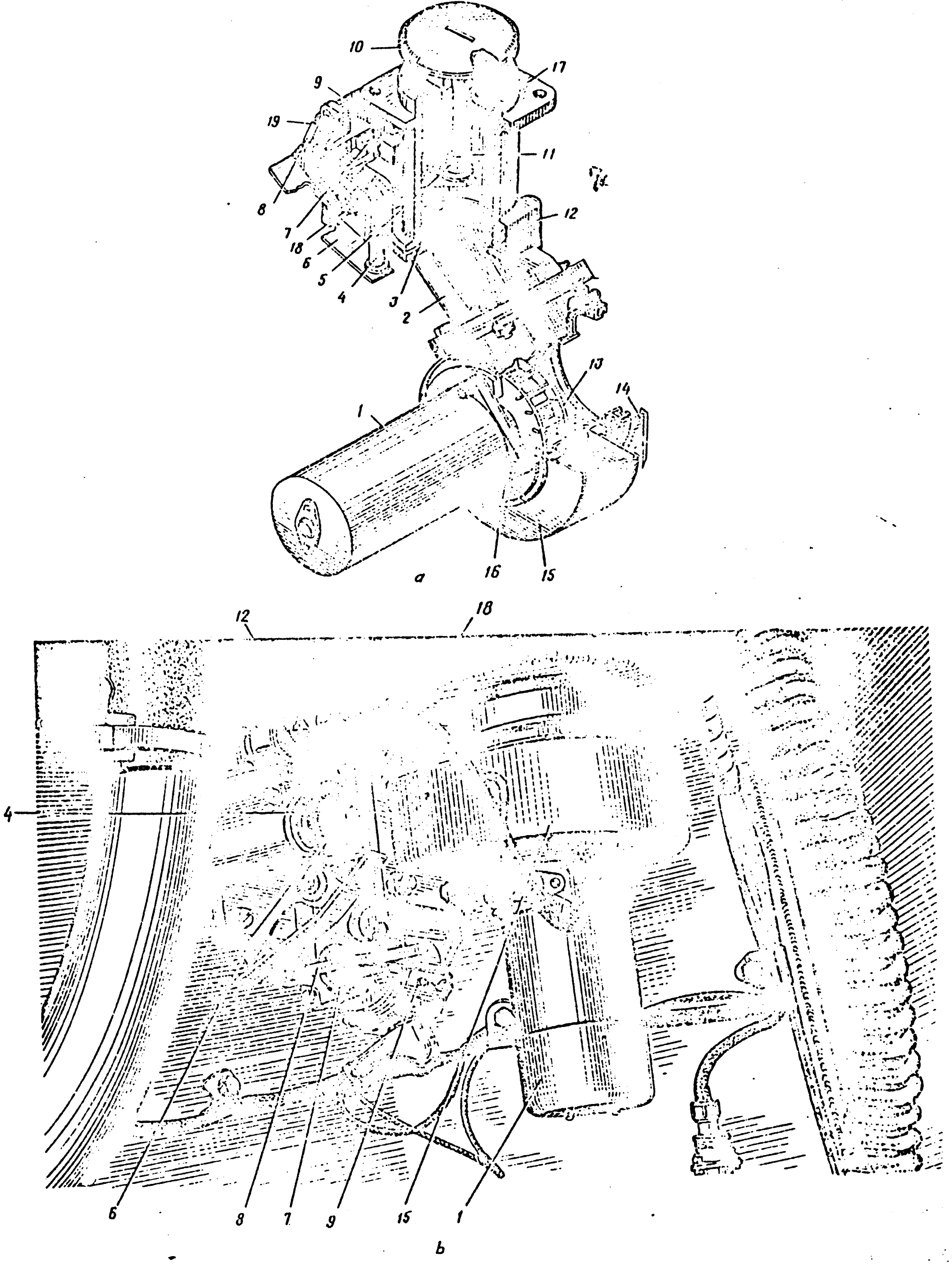
10
17
9
19
11
8
7
18
6
5
4
3
2
12
13
14
1
16
15
a
12
18
4
6
8
7
9
15
1
b

FIG.288. EXHAUST BLOWER WITH VALVE BOX

a - troop compartment blower; b - turret blower;
1 - electric motor; 2 - casing; 3 - push rod; 4 - limit switch rod; 5 - spring stop; 6 - handle; 7 - electromagnet armature; 8 - lock (latch); 9 - electromagnet (PII-1); 10 - valve; 11 - valve spring; 12 - valve box; 13 - blower; 14 - compensator; 15 - blower housing; 16 - bolt; 17 - valve box flange; 18 - handle axle; 19 - lock spring

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battery compartment with bolts 2.

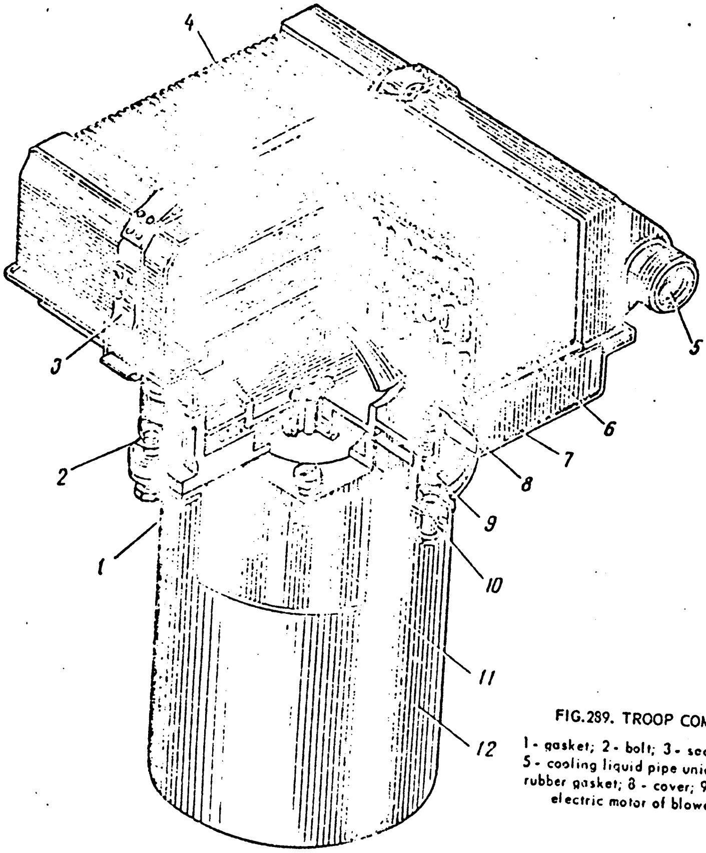

FIG.289. TROOP COMPARTMENT HEATER

1 - gasket; 2 - bolt; 3 - securing band; 4 - turnbuckle; 5 - cooling liquid pipe union; 6 - heater radiator; 7 - rubber gasket; 8 - cover; 9 - blower; 10 - support; 11 - electric motor of blower; 12 - casing

The heater consists of fin-and-tube radiator 6, blower 9, electric motor 11 closed with casing 12, pipelines, electric wires, a cock and a switch.

The radiator is secured with two bands 3 to the heater base and connected through pipe unions 5 and pipelines with the cooling system of the engine. Screwed to base 10 from below is electric motor 11 whose shaft carries blade blower 9. An access hatch provided in the battery compartment roof over the radiator is closed with a screen. With the blower switched on, the air passes through the radiator and through the screen into the troop compartment.

Part of air flows through a side air duct into the battery compartment to heat the storage batteries.

To switch on the heater, open cock 20 (Fig.176) located in the left-hand bay behind the commander (behind the filter-ventilating unit compartment) and close switch 18 (Fig.227).

With the cock set in the "O" (open) position, the liquid is supplied from the cooling system to the heater radiator.

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11.5. SEALING ASSEMBLIES

The vehicle is rendered tight by sealing the access holes, hatches and doors of the hull, turret hatches, race rings of the turret and commander's hatch with gaskets, and also by packing the protruding shafts and road wheel arms with cups and seals.

The ball supports of the trooper's small arms are packed with rubber sealings.

Apart from the permanent sealing devices, provision is made for special mechanisms which are open in normal service. Such devices seal the firing ports and other untight joints upon operation of the ABC protection system. Such mechanisms are: absorbent filter valve change-over mechanism, ejector louvres and shutters closing mechanism, exhaust blower valves closing mechanism, engine shut-down mechanism and traversing drive cut-off mechanism.

The absorbent filter valve change-over mechanism (Fig.287) is described in Subsection 11.2.

To change over the valve from supply to the filtration mode, close switch ПА3 or press button "P and OB" on the central panel. As a result, the mains current is supplied to relay box KP-40 of the ABC protection system, causing operation of the chemical protection relay PPOB (Fig.290) which closes the circuit of electromagnet 36 (Fig.287) of the filter-ventilating unit.

The electromagnet releases latch 35, and valve 5 cuts off the air supply to hollow support 1.

The design of the ejector louvres and shutters closing mechanism is shown in Fig.181 and described in Subsection 6.6.2.

With switch ПА3 closed on the central panel, the atomic protection relay in relay box KP-40 operates and closes the circuit of electromagnet 1 (ЭП-1) which displaces rod 4 and releases [illegible]. The latter come out of the groove of the sleeve and thus disconnect the latter from cam plates 7. Louvres 3 and shutters 2 close under the action of springs 26 and 36 (Fig.180). To open the louvres and shutters and to set the closing mechanism in the initial position, pull handle 10 down, with latch 11 being in the vertical position; prior to doing so, open switch ПА3.

The exhaust blower valve closing mechanism is described in Subsection 11.3.

As switch ПА3 is closed on the central panel, electromagnets 9 (Fig.288) of all the exhaust blowers are energized, and consequently valves 10 close and the blowers stop.

11.6. ACTUATING MECHANISMS

The engine shut-down mechanism (MOH) is connected to the fuel feed control linkage.

For the description of the design and operating principle of the mechanism, see Subsection 6.3.12.

As switch ПА3 is closed on the central panel, atomic protection relay PA3 (Fig.290) operates in relay box KP-40 and energizes electromagnet 16 (Fig.163) which pulls in the core with rod 29 and disconnects levers 32 and 33. As a result, the fuel feed control linkage is disengaged, and the engine is shut down.

The traversing drive cut-off mechanism is put in operation as switch ПА3 is closed on the central panel. As a result, the contacts of atomic protection relay PA3 (Fig.290) in relay box KP-40 close, and braking relay PT1 operates. The contacts of relay PT1 shunt the electric motor armature and open the control circuit of the electric traversing drive. Thus, the electric motor is abruptly braked, and the turret stops irrespective of the turn angle of the control unit body.

In this case, the gun can be elevated and brought to the angle of loading.

11.7. ELECTRICAL EQUIPMENT OF PROTECTION SYSTEM

The electrical equipment of the protection system is shown in Fig.290. It includes relay box KP-40, electric motors of the special blower and exhaust blowers, four fire-sensitive units, electromagnets, limit switches and signal lamps.

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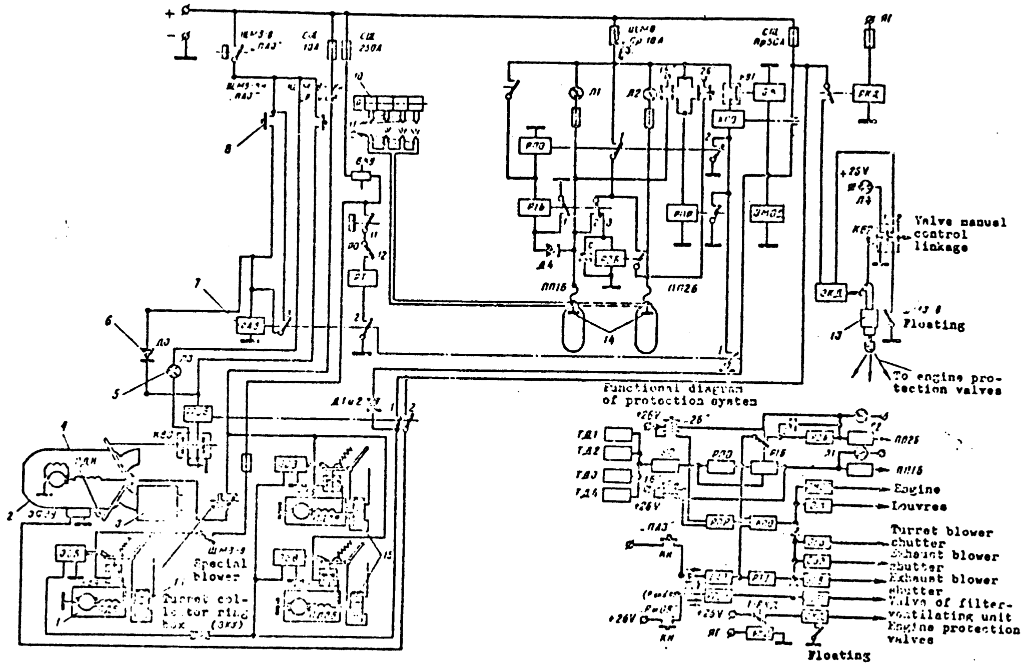
+
–
СЩ 10А
СЩ 250А
ШМ8 Пр 10А
СЩ Пр 5А
РАЗ
РРСЗ
РТ1
РО
Р1Б
Р2Б
РАР
ЭМОД
ЭК
РКД
КЭО
ЭКД
ЭДН
ЭСД
ЭВБ
ЭЗВ
ПП1Б
ПП2Б
Л1
Л2
Д4
Valve manual control linkage
Floating
To engine protection valves
Special blower
Turret collector ring box (ВКУ)
Functional diagram of protection system
+26V
ТД1
ТД2
ТД3
ТД4
ПАЗ
КН
Engine
Louvres
Turret blower shutter
Exhaust blower shutter
Exhaust blower shutter
Valve of filter-ventilating unit
Engine protection valves
Floating
1
2
3
4
5
6
7
8
11
12
13
14
15

FIG.290. CIRCUIT DIAGRAM OF PROTECTION SYSTEM

1 - turret exhaust blower; 2 - special blower; 3 - absorbent filter; 4 - limit switch; 5 - signal lamp; 6 - diode; 7 - relay; 8 - button on central panel; 9 - safety fuses; 10 - fire-sensitive unit signal amplifier (polarized relay P); 11 - fire-sensitive units; 12 - discharge nozzles of fire-fighting equipment; 13 - lock of engine protection mechanism; 14 - cylinders of fire-fighting equipment; 15 - exhaust blowers of troop compartment; 16 - turret exhaust blower; РРСЗ - radiological and chemical protection relay; РАЗ - atomic protection relay; РТ1 - traversing drive braking relay; РЭО - relay of electric protection devices arranged in front portion of vehicle; Р1Б - relay of first cylinder of fire-fighting equipment; Р2Б - relay of second cylinder of fire-fighting equipment; РАР - relay to provide semi-automatic operation of fire-fighting equipment; КЭО - contactor of electric protection devices arranged in front portion of vehicle; РКД - relay of engine protection valves; РО - common relay of turret traversing drive (contacts 11 and 12 actuating braking relay РТ1); ЭК - louvres electromagnet; ЭМОД - electromagnet of engine shut-down mechanism; ЭКД - electromagnet of engine protection valves; ЭЗВ - electromagnet of troop compartment exhaust blower; ЭВБ - electromagnet of turret blower; ЭФУ - electromagnet of filter-ventilating unit; ЭДН - special blower electromagnet; ЭДБ - turret blower motor; ЭВЗ - troop compartment blower motor; КВ1 - limit switch of louvres control linkage; КВ2 - limit switch of engine protection valves; КВ3 - limit switch of filter-ventilating unit; КВ4 - limit switch of turret exhaust blower; КВ5 and КВ6 - limit switches of troop compartment exhaust blowers; КнЗ - button ПАЗ - of atomic protection system on the central panel; КнЗ - button "РХСЗ" of radiological and chemical protection system; 1Б and 2Б - buttons of first and second cylinders of fire-fighting equipment (on central panel); Л1 and Л2 - signal lamps of fire-fighting equipment; 3 - signal lamp VALVE OPEN; 4 - signal lamp VALVE; Д1, Д2, Д3 and Д4 - insulating diodes; ТПУ - tank interphone system; С - shunting capacitor; К - fire-sensitive unit signal amplifier; ТД1, ТД2, ТД3 and ТД4 - fire-sensitive units; ПП1Б, ПП2Б - fire-fighting equipment cylinder squibs; ЩВ - driver's central panel; СЩ - power board

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The purpose of the components of the electrical equipment is indicated beneath the diagram.

11.8. OPERATION OF PROTECTION SYSTEM

To prepare the protection system for action, close switch ПАЗ on the central panel. Now, the circuits of atomic protection relay PA3, radiological protection and chemical protection relay PFOB are ready for operation.

As relay PA3 operates, its contacts close and switch on the contactor of the electr protection devices located in the front portion of the vehicle (КПО); the contactor oper and energizes the following electromagnets: electromagnet ЭМОД of the engine shut-down mechanism, electromagnet ЭЖ of the ejector louvres and shutters closing mechanism, elect magnet ЭВБ of the turret blower, electromagnet ЭВВ of the troop compartment exhaust blow

The engine stops, the louvres close, the turret blower shutters and the valves of t troop compartment exhaust blowers close, and the blowers stop.

As the engine stops, the relay of the engine protection valves (РКД) is deenergized and its contacts 1РКД close. If the engine is shut down when afloat, and when switch АРЛ is closed on the central panel, electromagnet ЭЖД operates, and the valves of the exhaus manifolds of the engine (engine protection mechanism) close.

Simultaneously, contacts 2 of relay PA3 close and switch on braking relay PT1 of gu traversing drive 1ЭЦ10М. As a result, the control circuit of the turret traversing drive disconnected, actuating electric motor ИД is changed over to brake and stops the turret.

This is the way the vehicle is sealed, and the effect of the shock wave of an atomi explosion is minimized.

Pressing button "P and OB" makes relay PFOB operate in relay box KP-40. As a result contacts 2 of this relay switch on electromagnet ЭЗВУ and change over the valve of the filter-ventilating unit, thus admitting the air through the absorbent filter only.

As the shock wave passes by, the driver should start the special blower by switch SPECIAL BLOWER on the central panel. The special blower supplies purified air to the abs bent filter, and creates an excess pressure inside the vehicle, thus preventing penetrat of radioactive dust.

11.9. CARE OF PROTECTION SYSTEM

The care of the protection system includes:

- cleaning of the system components from dust and dirt;
- regular checks of the actuating elements;
- lubrication of the movable (rubbing) parts of the mechanism;
- checks of the electric wire for proper connection, and the transmission devices f condition.

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12. FIRE-FIGHTING EQUIPMENT

12.1. PURPOSE AND COMPONENTS

The fire-fighting equipment (ППО) is designed to extinguish fire in the vehicle; it comprises an automatic fire-fighting system and a portable fire extinguisher.

12.2. AUTOMATIC FIRE-FIGHTING SYSTEM

The automatic fire-fighting system is intended to extinguish fire in the engine compartment.

It includes two cylinders 11 (Fig.291), main pipeline 3 with four discharge nozzles 1, 5, 13 and 19, two non-return valves 9, four fire-sensitive units 2, 6, 14 and 18, relay (in relay box КР-40) and fasteners.

The two-litre cylinders contain fire-extinguishing compound "3.5" (ethyl bromide and carbon dioxide). The cylinders are secured on brackets in the fighting compartment. Screwed into the upper neck of each cylinder is head 4 (Fig.292).

The cylinder head consists of body 5, diaphragm 10, piston 8 with a punch, and two plugs 7 and 14. Plug 7 has a cavity for a squib.

The head is screwed into the cylinder with its outer thread. Union nut 3 screwed on plug 7 has a drilled passage for squib supply wire 2.

The head is screwed into the cylinder head with its lower pipe union 18 having a taper thread. The pipe leading from the main pipeline is connected to side pipe union 6. The other side pipe union serves for charging the cylinder.

Screwed in this pipe union is plug 14, with seal 13, and screwed on this pipe union is nut 15 with a gasket.

Pipe 17 soldered in the lower pipe union of the head passes along the axis of the cylinder and almost reaches its bottom. When the cylinder is put in operation, the fire-extinguishing mixture is discharged through this pipe.

Diaphragm 10 is clamped by the plug between washer 11 and the circular shoulder of body 5. It closes the axial duct of the head, and thus disconnects the cylinder from the main pipeline. Piston 8 with the punch is arranged inside plug 7 and held in a suspended position by means of spring ring 9.

The upper portion of the piston has a boring to receive the squib.

The main pipeline (Fig.291) is, in fact, a long pipe running from cylinders 11 to the zone of engine 20 through engine compartment bulkhead 12. Pipes connected to the main pipeline through elbows 7 terminate in discharge nozzles: discharge nozzle 13 under the air cleaner, discharge nozzles 1 and 19 under the power plant, and discharge nozzle 5 over the gearbox.

Pipeline 15 running from the cylinders is sealed in the bulkhead of the engine compartment by means of rubber rings 17 that are clamped with a nut.

The non-return valves (Fig.293) are designed to prevent the flow of the fire-extinguishing compound "3.5" from one cylinder into the other.

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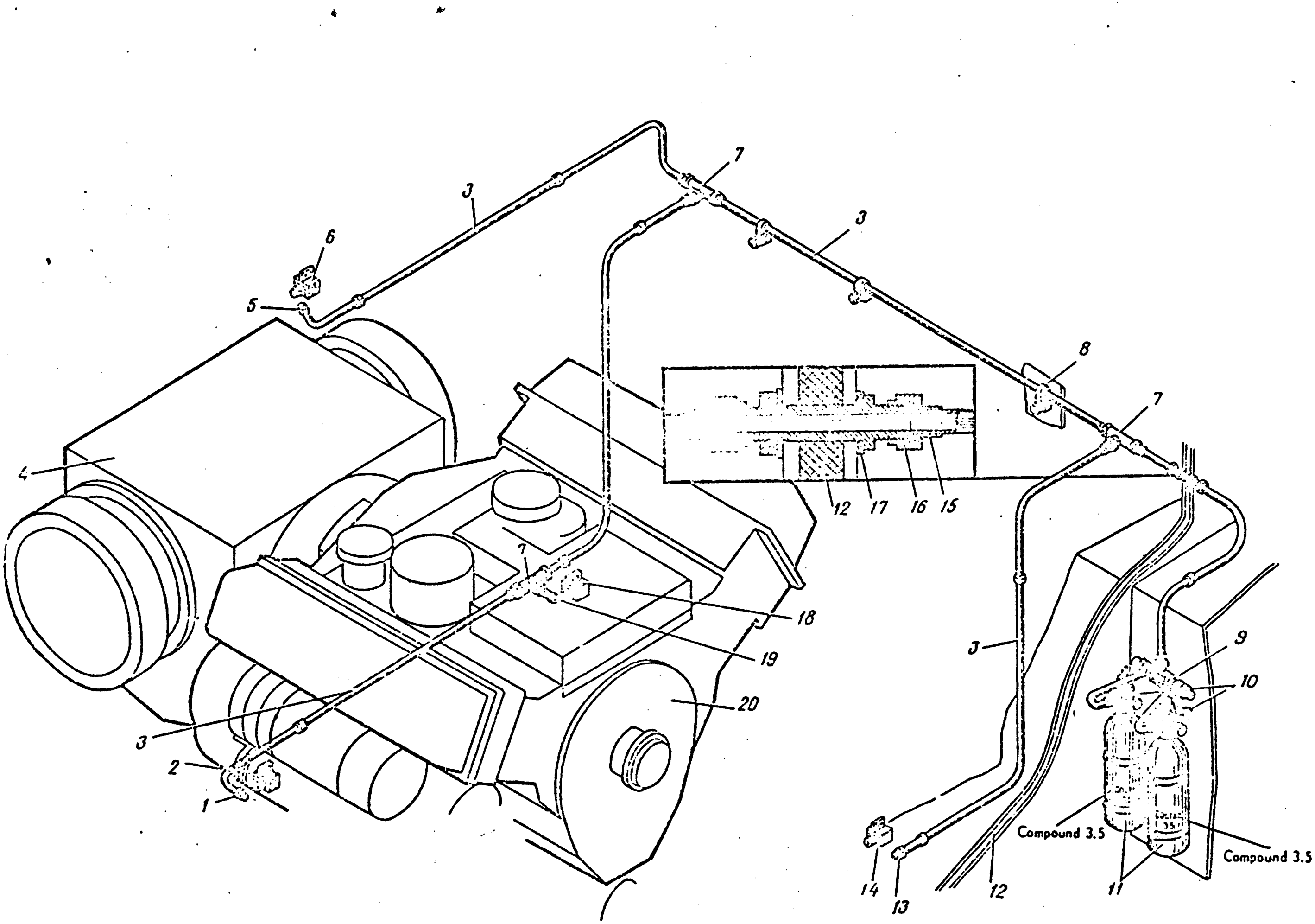
3
7
3
6
5
4
8
7
12
17
16
15
7
18
19
3
20
3
2
1
9
10
Compound 3.5
Compound 3.5
14
13
12
11

FIG. 291. FIRE-FIGHTING EQUIPMENT

1 - discharge nozzle under power plant; , 2 - lower fire sensitive unit; 3 - pipeline of fire-fighting equipment; 4 - gearbox; 5 - discharge nozzle over gearbox; 6 - upper fire-sensitive unit; 7 - T-piece; 8 - pipeline attachment to vehicle side; 9 - non-return valve; 10 - cylinder head; 11 - cylinders of fire-fighting equipment; 12 - engine compartment bulkhead; 13 - discharge nozzle located under air cleaner; 14 - rear fire-sensitive unit; 15 - pipeline running from cylinder; 16 - union nut; 17 - rubber ring (gasket); 18 - fire-sensitive unit located between cylinder blocks; 19 - upper discharge nozzle; 20 - engine

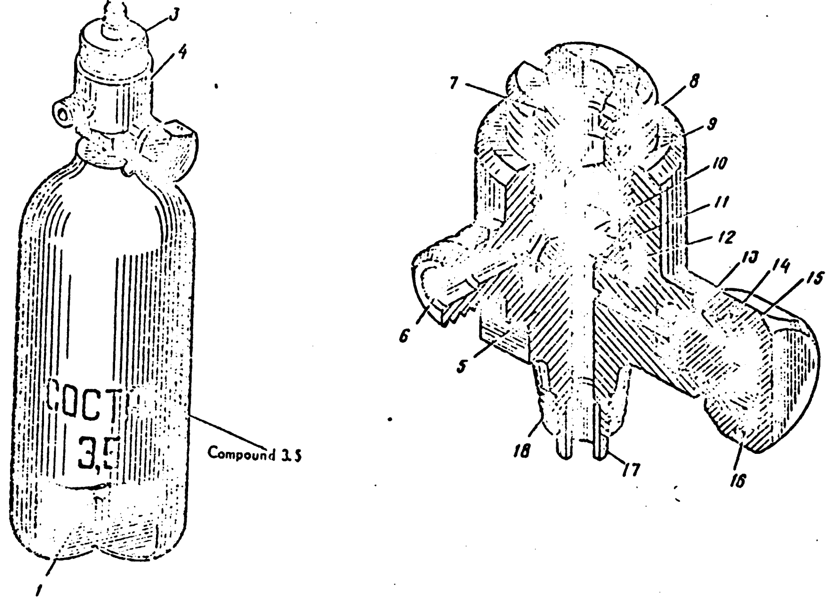

FIG.292. CYLINDER

1 - syphon pipe; 2 - electric wire; 3, 15 - union nuts; 4 - cylinder head; 5 - head body; 6 - outlet pipe union; 7 - plug, 8 - piston with punch; 9 - spring ring; 10 - diaphragm; 11 - washer; 12 - gasket; 13 - seal; 14 - plug; 16 - union; 17 - upper end of syphon pipe; 18 - lower pipe union

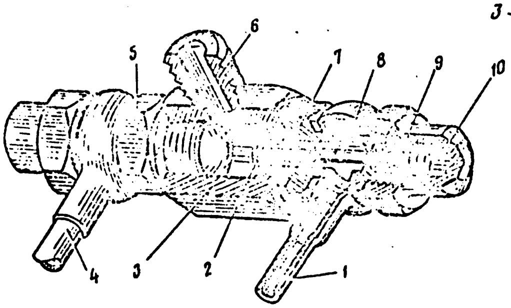

FIG.293. NON-RETURN VALVES

1 - pipe to first cylinder; 2 - first cylinder valve; 3 - valve pipe union; 4 - pipe to second cylinder; 5 - body of second cylinder non-return valve; 6 - thread to receive union nut of main pipeline; 7 - body of first cylinder non-return valve; 8 - valve rod; 9 - valve spring; 10 - union nut

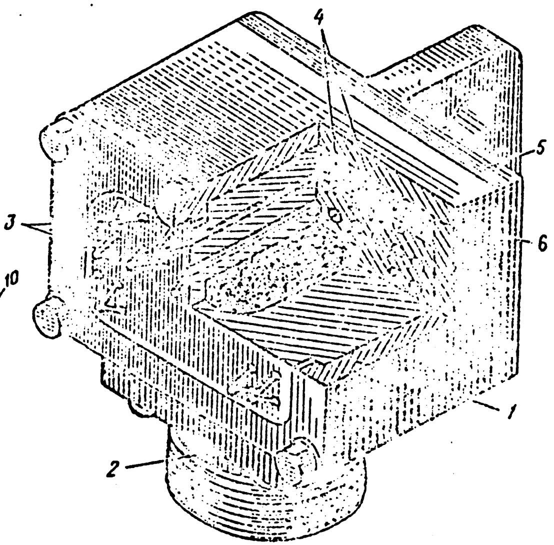

FIG.294. FIRE-SENSITIVE UNIT

1 - body of fire-sensitive unit; 2 - plug connecter; 3 - hot junctions of thermocouples; 4 - cold junctions of thermocouples; 5 - cover; 6 - block

[redacted]

[redacted]

The valves are mounted in bodies 5 and 7 [illegible]
valve 2 is pressed to the seat by spring 9. As the squib operates, the valve opens under the action of the pressure of the expanding fire-extinguishing mixture.

The fire-sensitive units (Fig.294) are designed for automatic transmission of a signal to the relay in the event of fire. They are arranged beside the discharge nozzles.

The body of the fire-sensitive unit is essentially a boxlike housing incorporating block 6 holding built-in thermocouples. The block is filled with binding agent. Fifteen thermocouples are the main components of the fire-sensitive unit; they are made from chromel-copel wire and connected in series.

A thermocouple is a wire element consisting of two junctions: cold junction 4 and hot junction 3.

As soon as the temperature abruptly rises, thermoelectromotive forces appear in this element.

Cold junctions 4 are located inside the fire-sensitive unit and filled with binding agent, and hot junctions 3 are brought outside; owing to which they are embraced with flame in the event of fire. As a result, a thermoelectromotive force is produced between the cold and hot junctions; when it reaches a certain value, it causes the polarized relay to operate.

The ends of the extreme thermocouples are connected with the contacts of plug connector 2 which is secured on body 1 of the fire-sensitive unit.

The body of the fire-sensitive unit is closed with a cover which is bolted to the mounting brackets.

Two relays P1Б and P2Б are designed to automatically close the circuits of the electric primers of the cylinder squibs when a signal is received from the fire-sensitive unit and [illegible] ensures semi-automatic operation of the fire-fighting equipment. The relays are [illegible] relay box KP-40.

Buttons 1 [illegible] on the central panel serve to manually put the fire-fighting equipment in operation. Button 1Б controls the first cylinder, while button 2, the second cylinder. The buttons are closed with covers bearing lead seals. To put the fire-fighting system in action, open the cover and press the button.

The fire-fighting system operates as follows.

As switch 24 BATTERY SWITCH (ВЫКЛ.БАТ.) (Fig.246) is closed, the mains voltage is applied to signal lamps Л1 and Л2 through safety fuse Пр10А (Fig.290). The lamps light up, indicating that the squibs of both cylinders are in good condition.

In the event of fire in the engine compartment, hot junctions 3 (Fig.294) of one of the fire-sensitive units heat, and thermoelectromotive force appearing in it, is applied to one of the four windings of the polarized relay. The relay operates and its closed contacts switch on relay РПО (Fig.290) and relay P1Б, forming the circuit of relay РПО (+26 V, fuse Пр10А, closed contacts of polarized relay, relay РПО, body) and the circuit of relay P1Б (+26 V, fuse Пр10А, closed contacts of polarized relay, relay P1Б, diode Д4, squib ПП1Б, body).

The squib does not operate in this case, since the operating current exceeds that of relay P1Б.

As relay P1Б operates, contacts 1 and 2 of relay РПО and contacts 1 and 2 of relay P1Б close and contacts 3 of relay P1Б open. Relay P2Б is shunted by capacitor "C" to prevent premature operation of relay P2Б when contacts 1 of relay РПО close, and to exclude possible delay in opening of contacts 3 of relay P1Б.

As contacts 1-РПО and 2P1Б close, the mains voltage is applied to squib ПП1Б of the first cylinder. The squib operates, and piston 8 (Fig.292) overcomes the resistance of spring ring 9 and moves down under the action of the powder gases. The punch breaks diaphragm 10, and the fire-extinguishing compound is forced from the cylinder to the four discharge nozzles in the engine compartment.

[redacted]

energizes electromagnets ЭМОД, ЭК, ЭББ and ЭБД; as a result, the engine stops, the louvres and valves of the exhaust blowers close, and the blowers stop.

Closed contacts 1 of relay Р1Б keep relay Р1Б energized, and contacts 3 of relay Р1Б open and break the circuit of relay Р2Б of the second cylinder.

While extinguishing the fire, compound "3.5" cools the thermocouples of the fire-sensitive units and the thermoelectromotive force disappears in them; as a result, the contacts of the polarized relay open and deenergize relays РПО and Р1Б.

Contacts 1 of relay РПО open and break the circuit of the squib, and simultaneously contacts 3 of relay Р1Б close, thus preparing the circuit of squib ПП2Б of the second cylinder.

If the fire would not be extinguished by the first cylinder, the fire-sensitive units heat again, thus causing operation of the polarized relay, but in this case its contacts energize relays РПО and Р2Б. The circuit of the first cylinder remains broken since the squib has operated.

The circuit of relay Р2Б is as follows: +26 V, safety fuse Пр10А, closed contacts 1 of relay РПО, normally-closed contacts 3 of relay Р1Б, relay Р2Б, body.

As relay Р2Б operates, its contacts close, and the mains voltage is applied to squib ПП2Б; as a result, the latter operates, and the fire-extinguishing compound is forced from the second cylinder to the discharge nozzles.

At the moment the squib is caused to operate, the circuit of the respective signal lamp is broken, and the lamp goes out, thus indicating to the fact that the fire-extinguishing compound of the given cylinder has been expended.

If the fire-fighting system would not be automatically put in action, do it manually, for which purpose press button 1Б or 2Б on the central panel.

As a result, the squib circuit and relay РПР causing semi-automatic operation of the fire-fighting equipment are energized.

The squib operates, and compound "3.5" is forced out of the cylinder, and relay РПР switches on contactor КПО of the front compartment. The contactor closes the electromagnet circuits in the same way as during automatic operation of the fire-fighting system; the engine and the blower stop, and the vehicle hull is sealed.

12.3. PORTABLE FIRE EXTINGUISHER

The ОУ-2 portable fire extinguisher (Fig.295) is intended to put out fire in the driving compartment and in the troop compartment. It is secured on a bracket in the troop compartment to the left of the door.

The fire extinguisher consists of two-litre steel cylinder 1, shut-off valve 3, safety valve 2, connecting pipe with nut 4, gland, funnel 5 and handle 6.

The cylinder is filled with carbon dioxide.

The shut-off valve consists of a body and a wing-nut with a stem whose end carries a taper valve which does not let the carbon dioxide escape from the cylinder. The stem is screwed into the body with its threaded end. The body of the shut-off valve has a taper thread, and it is screwed with its threaded portion into the cylinder neck. A bent syphon pipe secured in the lower portion of the valve is used to discharge the fire-extinguishing compound when the valve is opened.

The valve body has two pipe unions one of which holds a safety device consisting of a plug with six holes and a brass diaphragm. The diaphragm is rated at a pressure of 160--180 kgf/cm^2. When the pressure of the carbon dioxide exceeds this pressure (during heating), it breaks the diaphragm; carbon dioxide comes out of the cylinder, and explosion is prevented.

A pipe connected to the other pipe union of the valve body has an outer thread to receive funnel 5.

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The pipe is attached to the body by means of nut 4 having a gland.

The funnel is installed on a ball joint which makes it possible to freely turn the funnel in any direction.

In the event of fire, remove the fire extinguisher, turn funnel 5 towards the seat of fire and turn off shut-off valve 3. Carbon dioxide discharge lasts for 8-10 s.

In service, avoid excessive heating of the fire extinguisher, since, if the temperature reaches 50-60°C the pressure may exceed the permissible value, break the diaphragm and result in discharge of carbon dioxide through the safety device.

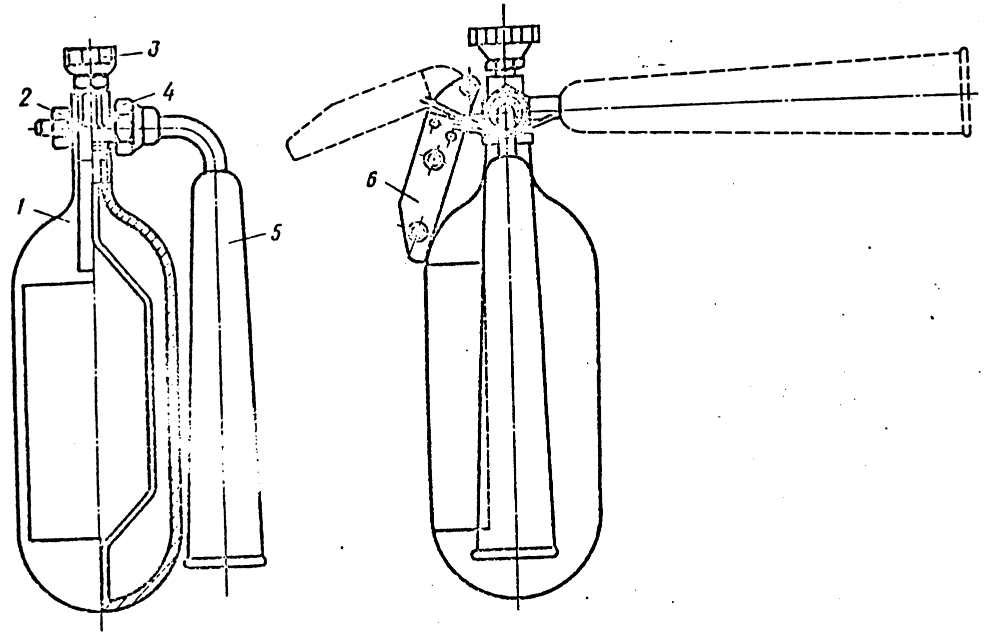

FIG.295. PORTABLE FIRE EXTINGUISHER ОУ-2

1 - cylinder; 2 - safety valve; 3 - shut-off valve; 4 - union nut; 5 - funnel; 6 - handle

12.4. CARE OF FIRE-FIGHTING EQUIPMENT

The care of the fire-fighting equipment includes: examination of the electric wires for condition; checking of the pipelines for secure attachment to the cylinder heads; checking of the fire-sensitive units and electric circuits of the squibs for condition and serviceability.

Once every year weigh the cylinders. Once every three months check the weight of the carbon dioxide in the portable fire extinguisher. The care also includes replacement or charging of the cylinders upon expending the carbon dioxide. Daily check the signal lamps of the fire-fighting equipment.

Replace the cylinders as follows:

(a) make sure that the battery switch is opened;

(b) unlock and unscrew union nuts 3 (Fig.292) and remove the squibs;

(c) unlock and unscrew union nuts 10 (Fig.293) and disconnect pipelines 1 and 4 from the cylinders;

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(e) remove the cylinders of the fire-fighting equipment;

(f) install the charged cylinders, tighten up the bolts of the securing bands and lock them;

(g) connect the pipelines to the cylinders, tighten up the union nuts and lock them;

(h) mount the squibs, screw on the union nuts and lock them.

The fire-sensitive units and the circuits of the fire-fighting equipment are checked for serviceability with a tester (Fig.296) which represents panel 5 mounting two lamp holders 3 with lamps 3 and 4 (28 V, 10 W) and two pipe unions 2 which are threaded to receive union nuts 3 (Fig. 292) of the cylinders with spring contacts 1 (Fig. 296), and 24-V portable electric heater.

Perform the check as follows:

(a) raise the front ribbed plate of the hull and lock it;

(b) unscrew union nuts 3 (Fig.292) from the cylinders together with the wires;

(c) screw the union nuts on pipe unions 2 (Fig.296) of the tester as far as they will go. See that, signal lamps 10 and 14 (Fig.246) light up and burn at full glow on the central panel, thus testifying to serviceability of the electric circuits of the squibs;

(d) close battery switch 24;

(e) insert the plug of the portable heater in the socket of the fighting compartment and let it heat for 15 min;

(f) bring the heater to one of the fire-sensitive units from the side of [illegible] hot junctions (take care not to touch the thermocouple ends with the metal parts of the heater body). Not later than 20 s [illegible] that, one of the tester lamps must light up and burn at [illegible] glow, and lamp 10 on the central panel should go out;

(g) move the heater away from the fire-sensitive unit, and wait until the tester lamp goes out; lamp 10 should burn at half glow;

(h) check the other fire-sensitive units for serviceability;

(i) switch off the heater and open the battery switch;

(j) unscrew the union nuts from the tester and screw them on the cylinder heads;

(k) reinstall the front ribbed plate of the hull.

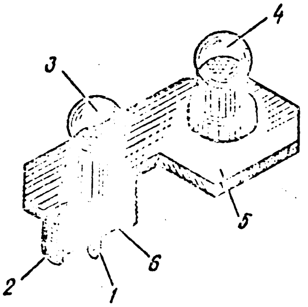

FIG.296. TESTER FOR CHECKING THE ELECTRIC CIRCUITS OF SQUIBS

1 - spring contact; 2 - pipe union; 3, 4 - lamps; 5 - panel; 6 - insulator

Perform the checking of the fire-fighting equipment when manually putting it in operation as follows:

(a) close the battery switch;

(b) unlock and unscrew union nuts 3 (Fig.292) with wires from the cylinder heads;

(c) screw union nuts 3 on the tester (Fig.296) as far as they will go.

Make sure that signal lamps 10 and 14 (Fig.246) light on the central panel and burn at half glow;

(d) open the louvres and shutters of the ejector, and the covers of the exhaust blowers (in this case, the exhaust blowers are started);

(e) start the engine and set the minimum steady speed;

(f) press button 15 on the central panel and see that one lamp of the tester burns at full glow, lamp 10 on the central panel goes out, the engine stops, the exhaust blower covers and the ejector louvres and shutters close;

(g) release button 15 and see that lamp 10 on the central panel burns at half glow, and the lamp of the tester goes out;

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NOTE: PG. 448 IS AT PAPER CLIP FOLLOWING PG. 561 IN TABLE OF CONTENTS (FRONT OF MANUA

(h) open the ejector louvres and shutters and the exhaust blower covers and set the engine shut-down mechanism in the initial position.

Start the engine and set the minimum steady speed;

(i) press button 2B on the central panel, check the electric circuits of the second cylinder in the same way as those of the first cylinder; but in this case, the other lamp must light up on the tester and lamp 14 should go out on the central panel;

(j) unscrew union nuts 3 from the tester (Fig.296), screw them on the cylinder heads, and lock.

Perform the checking of the automatic control system of fire-fighting equipment as follows:

(a) raise the front ribbed plate of the hull and lock it;

(b) close the battery switch;

(c) open the ejector louvres and exhaust blower covers;

(d) unlock and unscrew union nuts 3 (Fig.292) with wires from the cylinder heads;

(e) screw union nuts 3 on pipe unions 2 (Fig.296) of the tester as far as they will go, and see that lamps 10 and 14 (Fig.246) light up on the central panel and burn at full glow, testifying to good condition of the squib circuits;

(f) start the engine and set the minimum steady speed;

(g) insert the heater plug in the socket of the fighting compartment and 15 min later bring it close to one of the fire-sensitive units (take care not to touch the thermocouple ends by the metal parts of the tester body).

See that not later than in 20 s one of the tester lamps lights up and burns at full glow, lamp 10 on the central panel goes out, the engine stops, the ejector louvres and shutters and the exhaust blower covers close;

(h) move the heater away from the fire-sensitive unit, and wait until the tester lamp goes out; unscrew the lamp from the tester. Open the battery switch and close it again 2 or 3 s later;

(i) open the ejector louvres and shutters and the exhaust blower covers and prepare the engine shut-down mechanism for operation;

(j) start the engine and set the minimum steady speed;

(k) check the other fire-sensitive units for serviceability in the same way;

(l) the check over, open the ejector louvres and shutters and the exhaust blower covers and set the engine shut-down mechanism in the initial position;

(m) unscrew the union nuts from the tester and screw them on the cylinder heads;

(n) open the battery switch;

(o) reinstall the front ribbed plate of the hull.

12.5. TROUBLES AND REMEDIES

Trouble	Cause	Remedy
With buttons 1B and 2B pressed on central panel, cylinders fail to operate	10-A safety fuse on central panel blown out No squibs in cylinder heads	Replace safety fuse Mount squibs and connect wires
With battery switch closed, one of signal lamps on central panel is dark	Lamp burnt out Squib circuit faulty 10-A safety fuse on central panel blown	Replace lamp Check circuit and eliminate fault Replace safety fuse

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	Cause	Remedy
As heater is brought to one of fire-sensitive units, lamp on central panel fails to go out	Thermocouples dirty or closed to body	Clean or dress thermocouples. If trouble persists, replace fire-sensitive unit
	Fire-sensitive unit insufficiently heated	Check battery voltage. It should not be less than 22 V.
	Relay in relay box KP-40 faulty	Check and, if necessary, send relay box for repair
With button 1Б or 2Б pressed on central panel, some actuating mechanisms (engine shut-down mechanism, ejector louvres and shutters, or blower valves control linkage) fail to operate	Circuits of actuating mechanism electromagnets faulty	Check circuits and eliminate fault
	Electromagnets faulty	Check, and, if necessary, replace electromagnet
	Actuating mechanism faulty	Check valve or louvres and shutters control linkages, eliminate fault
	Relay РПО in relay box KP-40 faulty	Check and, if necessary, replace relay box KP-40 or send it for repair

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13. SMOKE-GENERATING SYSTEM

13.1. PURPOSE OF SYSTEM

The smoke-generating system (TДА) is designed for multiple use. It operates on diesel fuel supplied from the engine fuel feed system.

The smoke-generating system serves for laying smoke screens to conceal one vehicle or a group of vehicles.

The principle of operation is based on injection of atomized fuel into the stream of exhaust gases in the exhaust manifolds; as a result of quick evaporation, the atomized fue is mixed with combustion gases, forming a steam-gas mixture.

13.2. CONSTRUCTION

The smoke-generating system consists of pump 20 (Fig.297), electric motor 18, electric valve 23, filter 26, non-return valve 7, injectors 4 and 11, two valves for scavenging the injectors (non-return valves), and a system of pipelines and electric wires.

The gear pump takes fuel from the pipeline of the engine fuel feed system running from the tank and feeds it to the smoke-generating system.

The pump is located in the troop compartment under the right-hand troopers' seat near the battery compartment.

The pump and the rear water-drainage pump form a single unit. It is driven by shaft 10 (Fig.298) of the electric motor. The pump consists of housing 1 with cover 5 secured by studs 7 to reduction gear case 13, coupling 9, two gears 6 and ball by-pass valve 15. Fuel enters the pump through pipe union 2 and flows to the smoke-generating system through pipe union 4.

Electric motor 18 (Fig.297), type МВП-2, is hermetically sealed; it is mounted on a be welded to cross beam 12 (Fig.299) of the troop compartment bottom; the electric motor is attached to the bed with steel band 11. Bolted to the flange of electric motor 6 is the flange of reduction gear 4 which serves to drive pump 15 of the smoke-generating system and rear water drainage pump 1. Key-fitted on shaft 10 (Fig.298) of the electric motor is shaft 11 driving the pump of the smoke-generating system. Driving gear 12 made integral with sha 11 drives bevel gear 14 of the water drainage pump drive.

To connect the inner space of the electric motor with the atmosphere, the front end shield has a drilled hole and a welded nipple to which a pipe is connected through a durite hose. The pipe end is bent upward.

Electric valve 23 (Fig.297) is intended to control the fuel feed from the fuel main 1 to the fuel pump of the smoke-generating system. It prevents fuel leakage through smoke-generating system when the latter is not used.

The electric valve is secured on a bracket attached to the vehicle bottom, near the el tric motor.

It consists of body 9 (Fig.300), electromagnet 7 (РП-1), valve 2 with rod 10 and spri 11, inlet pipe union 15 and outlet pipe union 1.

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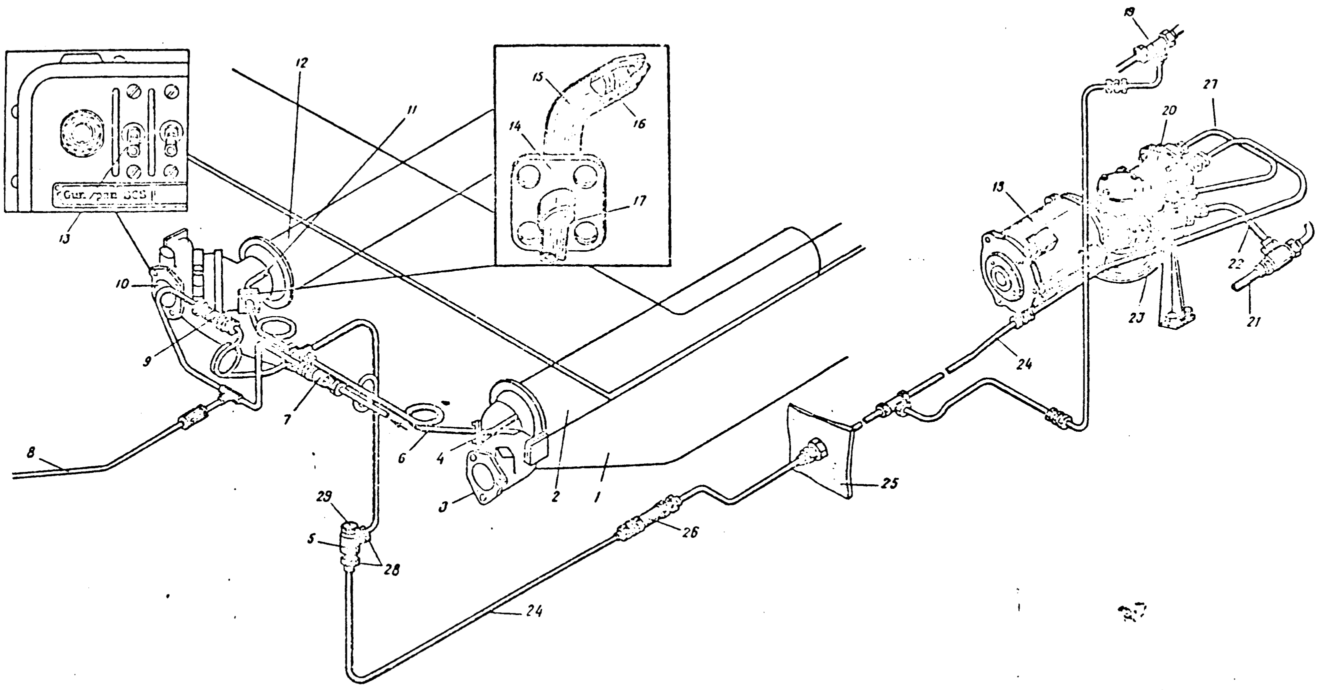

FIG.297. SMOKE-GENERATING SYSTEM

1 - ejector box; 2 - right-hand exhaust manifold of ejector; 3 - valve box of engine protection system; 4 - right-hand injector; 5 - non-return valve; 6 - injectors fuel supply pipeline; 7 - right-hand injector scavenging valve (non-return valve); 8 - fuel drain pipe; 9 - left-hand injector scavenging valve (non-return valve); 10 - valve box; 11 - left-hand injector; 12 - left-hand exhaust manifold of ejector; 13 - switch of smoke-generating system ([illegible]A) on central panel; 14 - injector flange; 15 - injector body; 16 - swirler; 17 - injector fuel supply pipeline; 18 - electric motor of smoke-generating system pump and rear water drainage pump; 19 - T-piece; 20 - fuel pump of smoke-generating system; 21 - pipeline of engine fuel system; 22 - fuel feed pipeline; 23 - electric valve; 24 - main pipeline; 25 - engine compartment bulkhead; 26 - filter; 27 - fuel pipeline; 28 - union nuts of non-return valve; 29 - non-return valve stop

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strap 5. The electromagnet is energized through lead-in 4 upon closing switch ТПА on the central panel. Electromagnet armature 8 is connected with valve rod 10 by means of pin 9.

As switch ТПА is closed, the electromagnet armature is pulled in, thus displacing the valve rod and valve, and connecting the inlet and outlet pipe unions; now, the fuel flows from the main line to the fuel pump of the smoke-generating system.

Filter 26 (Fig.297) is a cylinder with a screen. It is arranged in the engine compartment on the pipeline feeding the fuel to the injectors.

Non-return valve 5 serves to prevent penetration of the waste gases and air from the exhaust manifolds to the main pipeline of the smoke-generating system, when the latter is not used. It consists of body 1 (Fig.301), stop 2 screwed into the latter, ball 6, spring 4, inlet pipe union 7 and outlet pipe union 5.

In the initial position ball 6 is pressed by spring 4 to the body seat, and therefore the pipe unions are disconnected. With the pump operating, the fuel jet opens the valve. Wh the smoke-generating system is idle, ball 6 prevents gas flow from the exhaust manifolds.

The open-type injectors are designed to atomize the fuel fed to the exhaust manifolds of the ejector. They are secured by means of flanges 14 (Fig.297) and bolts to the manifolds

The injector represents a bent pipe terminating in a cone at the end and holding swirler 16 which provides swirling and atomization of the fuel jet.

The swirler represents a steel stem having a deep-cut triple-start square thread.

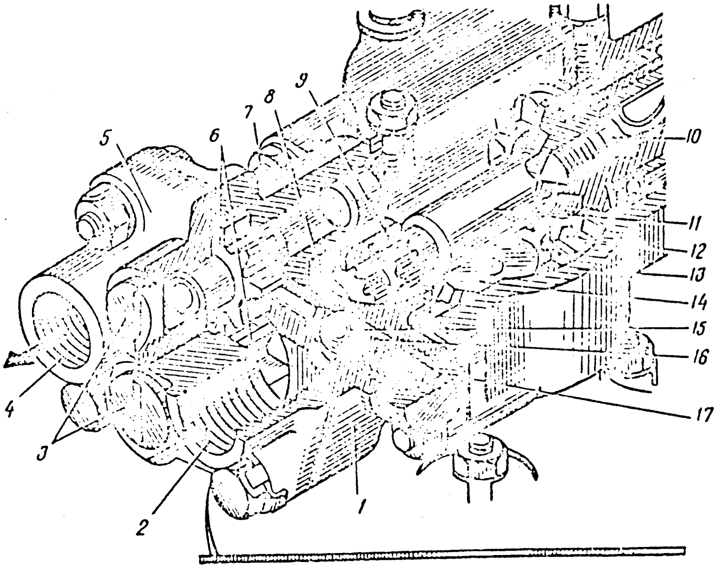

FIG.298. PUMP OF SMOKE-GENERATING SYSTEM

1 - pump housing; 2 - inlet pipe union; 3 - screw caps; 4 - outlet pipe union; 5 - pump cover; 6 - pump gears; 7 - pump securing stud; 8 - self-tightening cup; 9 - coupling; 10 - motor shaft; 11 - pump drive shaft; 12 - driving gear; 13 - reduction gear case; 14 - water drainage pump drive gear; 15 - by-pass valve; 16 - valve spring; 17 - plug

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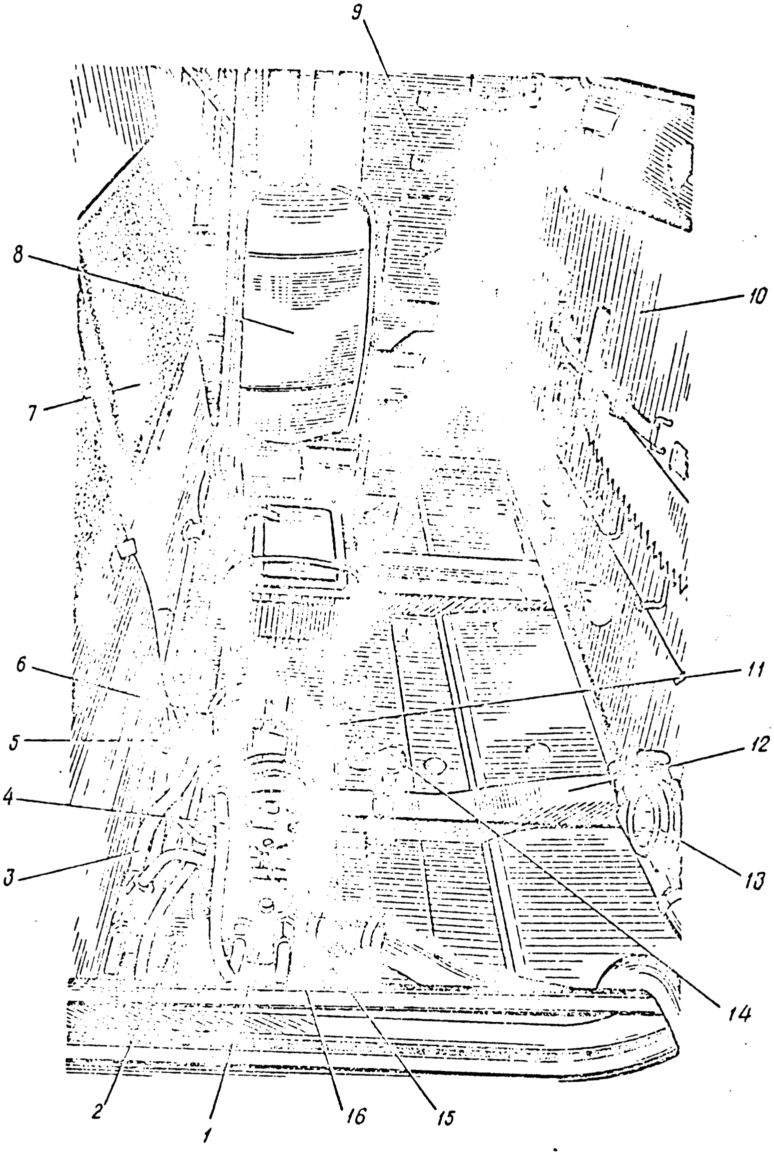

FIG. 299. ARRANGEMENT OF SMOKE-GENERATING SYSTEM PUMP

1 - rear water drainage pump; 2 - drain valve; 3 - fuel pipeline running from tank; 4 - pump reduction gear; 5 - electric valve; 6 - electric motor; 7 - troopers' seat backrest; 8 - guard; 9 - engine compartment bulkhead; 10 - right side of vehicle hull, 11 - motor securing band; 12 - cross beam; 13 - idler wheel crank axle, 14 - pipeline to discharge water from rear water drainage pump; 15 - pump of smoke-generating system; 16 - intake screen of water drainage pump

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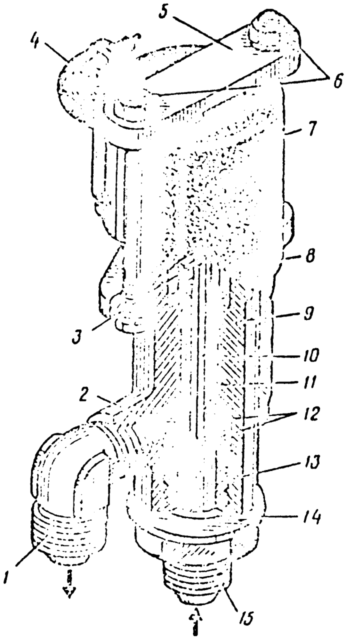
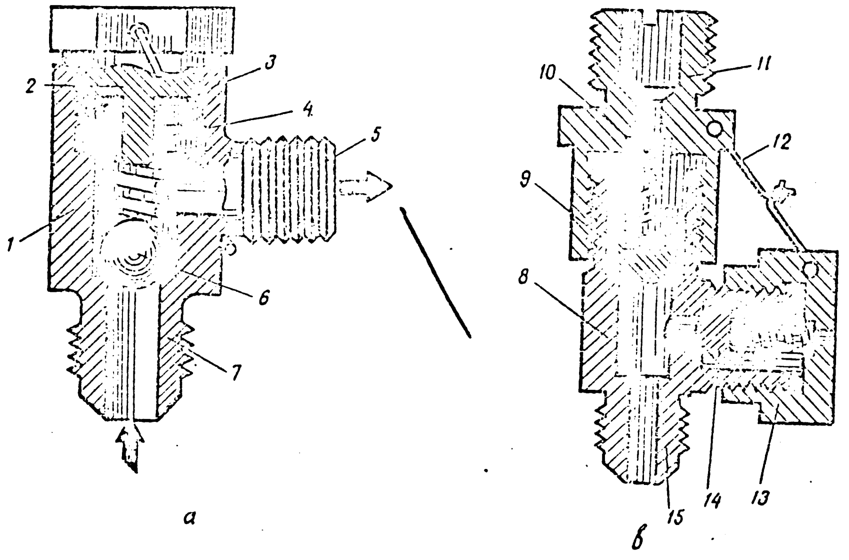


FIG. 300. ELECTRIC VALVE OF SMOKE-GENERATING SYSTEM

1 - outlet pipe union; 2 - valve; 3 - pin; 4 - electric lead-in; 5 - strap; 6 - electromagnet securing bolt; 7 - electromagnet; 8 - electromagnet armature; 9 - valve body; 10 - valve rod; 11 - valve spring; 12 - rubber washers; 13 - valve seat; 14 - gasket; 15 - inlet pipe union



a

б

FIG. 301. NON-RETURN VALVE AND INJECTOR SCAVENGING VALVE

a - non-return valve; b - injector scavenging valve;
1 - non-return valve body; 2 - spring stop; 3 - adjusting washer; 4 - spring; 5, 11 - outlet pipe unions; 6 - valve ball; 7, 15 - inlet pipe unions; 8 - injector scavenging valve body; 9 - injector scavenging valve; 10 - valve spring; 12 - locking wire; 13 - union nut; 14 - safety valve

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system. Both valves are successively built in the air pipeline connected with injector fuel supply pipeline 6. The valves are arranged in the engine compartment over the engine.

The valve assembly consists of body 1 with inlet pipe union 15, outlet pipe union 11, valve 9 and spring 10. The body has a side threaded pipe union which is closed with union nut 13; the pipe union holds safety valve 14 with a spring.

During injector scavenging the air enters the valve through pipe union 15, presses off valve 9 and flows to the injectors. When out of action, valve 9 is pressed by spring 10 to the seat, thus preventing fuel passage to the pneumatic system.

Safety fuse 14 prevents pressure rise above the permissible value.

The system of pipelines includes pipeline 22 (Fig.297) connected by means of a union nut with the pipe union of fuel pipeline 21 connecting the tank of the right-hand rear door with the main tank; fuel pipeline 27 connecting the electric valve with the fuel pump; main pipeline 24 connecting the fuel pump with fuel pipeline 6 running to the injectors; air pipeline connecting the oil settler of the engine air-starting system with oil pipeline 6; pipe 8 terminating in a jet which serves to discharge fuel leaking through injector scavenging valves 7 and 9.

13.3. OPERATION OF SMOKE-GENERATING SYSTEM

For laying a smoke screen, close switch TRA on the central panel. As a result, armature 16 (Fig.302) of the electromagnet opens valve 19; electric motor 1 of the drive of pump 24 starts operating and the pump starts feeding fuel to the system. Fuel jet passing through the swirlers of injectors 5 and 9 is atomized by the square thread and supplied into injector exhaust manifold 12. Under the effect of high temperature of the exhaust gases the fuel is vaporized in the manifolds, forming a steam-gas mixture. As the temperature of the steam-gas mixture is considerably higher than that of the outside air, the mixture is condensed at the injector outlet, forming a dense fog.

Before putting the smoke-generating system in operation, warm up the engine properly; to obtain a dense smoke screen, move at maximum permissible speeds so as to load the engine.

The most effective screen laying is provided when the vehicle moves in the fourth gear at the engine speed in the range from 2000 to 2400 rpm. In this case, the coolant temperature should not be less than 90°C.

Continuous operation of the smoke-generating system is not allowed for longer than 5 min. On expiration of this period switch off the smoke-generating system. Put the smoke-generating system in operation again not earlier than in 3 min.

After the smoke-generating system is out of operation, let the engine run for 2-3 min at a speed of 2000-2400 rpm in order to remove unburnt fuel.

If the engine suddenly stops, with the smoke-generating system switched on, fuel may ignite in the ejector. To avoid it, switch off the smoke-generating system, start the engine and run it for 2-3 min at a speed of 2000 to 2200 rpm.

It is allowed to lay screens on the move only. To lay a continuous screen, avoid gear shifting. If the smoke screen ignites, switch off the smoke-generating system for 2-3 s.

13.4. CARE OF SMOKE-GENERATING SYSTEM

Care of the smoke-generating system includes examining of the pipeline and electric wire connections, checking the reduction gear motor, pump and electric valve for reliable attachment; examining the fuel drain pipeline and washing the non-return valve of the smoke-generating system.

To wash the non-return valve, proceed as follows:

(a) Turn the turret to the right by 120° and remove cover 21 (Fig.15) from the engine compartment bulkhead.

[redacted]

(d) Remove the collar from the valve body.

(e) Unscrew stop 2 (Fig.301) of the non-return valve.

(f) Take spring 4, washers and ball 6 out of valve body 1.

(g) Wash the valve body, stop, washers, spring and ball in pure diesel fuel.

(h) Place the ball and spring in the valve body, and screw in the stop with washers, taking care that all the washers removed during disassembly are reinstalled.

(i) Fit the collar on the valve body.

(j) Lock the valve stop.

(k) Secure the non-return valve.

(l) Screw the union nuts on the pipe union of the non-return valve and lock them.

(m) Put the cover on the access hole of the engine compartment bulkhead and secure it.

13.5. TROUBLES AND REMEDIES

Trouble	Cause	Remedy
With switch TДА closed, smoke-generating system fails to operate	50-A safety fuse on central panel blown	Replace safety fuse
	Air in injector fuel supply pipelines	Release air, for which purpose: - unscrew stop 29 (Fig.297) of non-return valve and open switch; - screw in stop and lock it
	Break in circuit of relay of electric valve 23	Check circuit and eliminate fault
Fuel leakage from drain pipe 8	Injector scavenging valves 7 and 9 clogged	Wash valves
With smoke-generating system switched on, smoke screen is not continuous	Engine insufficiently warmed up	Warm up engine

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14. EQUIPMENT FOR MOVEMENT ON WATER

14.1. COMPONENTS OF EQUIPMENT -

The equipment which is used when moving on water is shown in Fig.303.

The set of the equipment designed for use when crossing water obstacles includes:

- splash panel 1 with two pneumatic cylinders 3 and control leverage;
- periscopic vision device 6 (ТНПО-350Б);
- grills of guide vanes 19 at the rear of the fenders;
- engine water protection mechanism with control handle 7;
- pneumatic control system designed to raise air intake pipe 17, the splash panel 1 and the air cleaner dust suction valve;
- rear door locking mechanism 22;
- valve 30 to drain water from the driving compartment to the engine compartment;
- winter shutter of air cleaner 2 (Fig.169);
- three water drainage pumps and signal lamps on the central panel.

For design and operating principle of the equipment see the respective sections of the book; the water drainage facilities are described below.

14.2. VEHICLE BUOYANCY

The vehicle possesses floatability and retains it even if some water penetrates inside the hull through untight joints.

No special jobs are required to prepare the vehicle for movement on water. The crew members should not forget that before moving into water, they should tighten up hole covers and plugs on the vehicle hull and bottom and dog down the rear doors.

The vehicle moves on water due to motion of the tracks. To provide better traction, the upper runs of the tracks are closed with side fenders, and guide vanes are provided behind the latter.

The vehicle is steered on water by the same controls as on land.

14.3. WATER-DRAINAGE FACILITIES

The water-drainage facilities are designed to remove water which penetrated inside the vehicle through untight joints when afloat.

There are three water drainage pumps: front and rear electric pumps, and mechanical pump actuated by the engine through the compressor drive and arranged in the engine compartment.

Rear water drainage pump 1 (Fig.299) is located in the rear section of the troop compartment under the right-hand seat. It is made as a single unit with fuel pump 15 of the smoke-generating system and driven by bevel gear 12 (Fig.304) fitted on shaft 11 of electric motor 10 (МБП-2).

The pump consists of housing 3 (volute), impeller 4, impeller shaft 16 and self-tightening cup 6.

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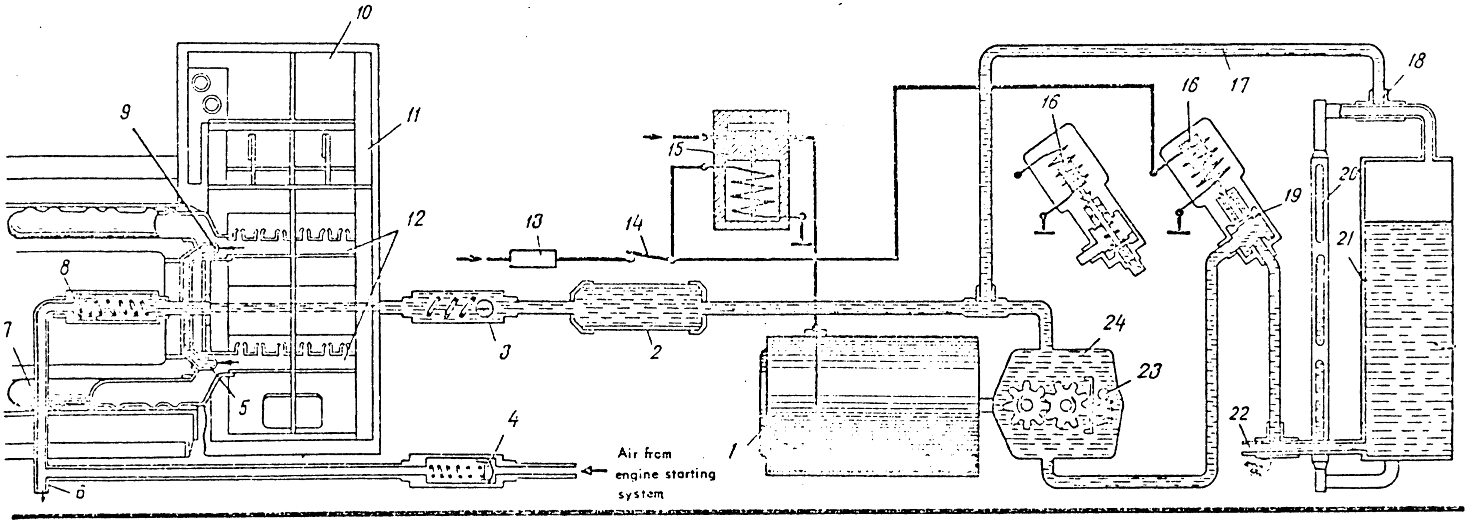
10
9
11
12
8
7
5
6
4
3
2
13
14
15
Air from
engine starting
system
1
16
16
17
18
19
20
21
22
23
24

FIG. 302. SCHEMATIC DIAGRAM OF SMOKE-GENERATING SYSTEM OPERATION

1 - electric motor; 2 - filter; 3 - non-return valve; 4 - injector scavenging valve; 5, 9 - injectors; 6, 18 - jets; 7 - engine exhaust manifolds; 8 - injector scavenging valve; 10 - exhaust gas outlet; 11 - ejector; 12 - exhaust manifolds of ejector; 13 - safety fuse of supply circuit of smoke-generating system; 14 - switch ТДА on central panel; 15 - relay; 16 - armature of electric valve electromagnet; 17 - drain pipeline; 19 - valve; 20 - fuel level gauge; 21 - main fuel pipeline; 22 - pipeline of engine fuel system; 23 - by-pass valve; 24 - pump of smoke-generating system

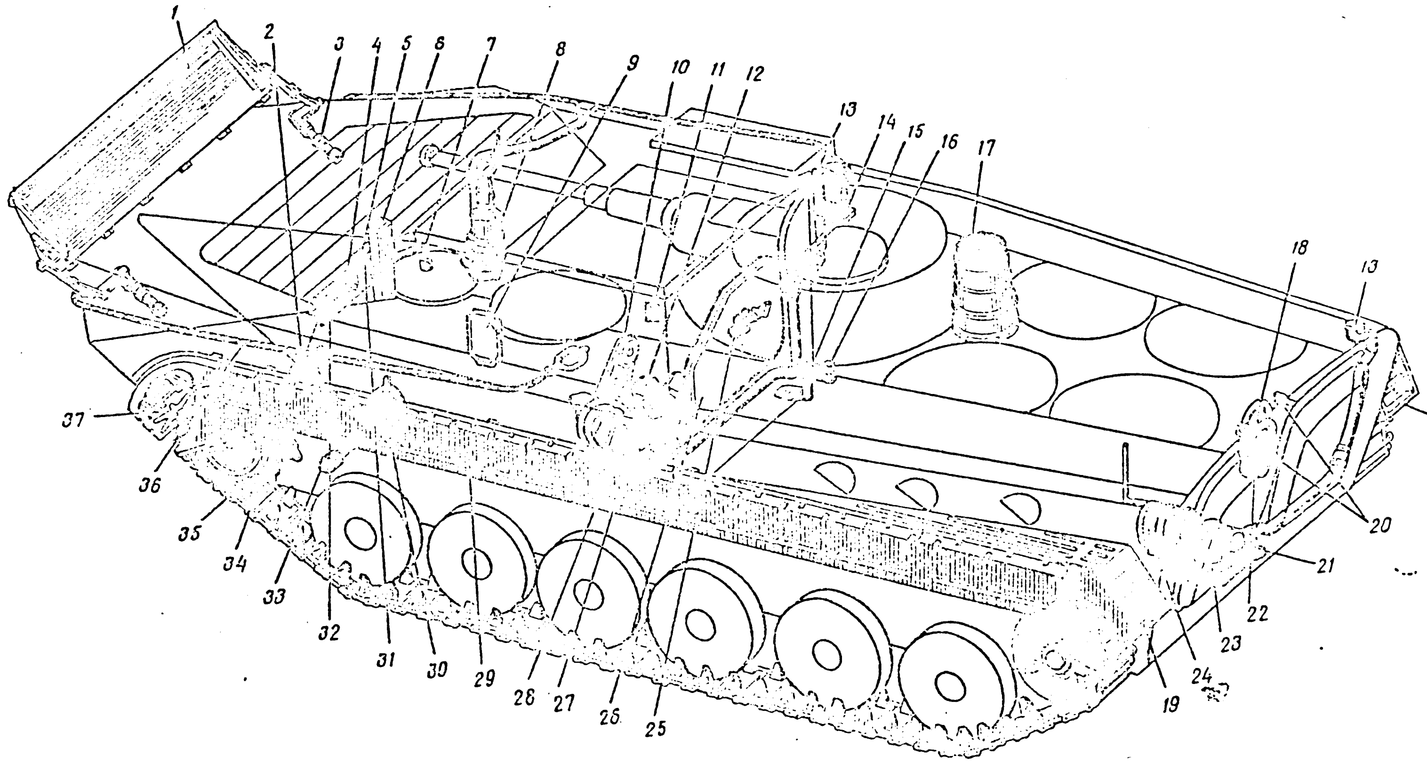

FIG.303. ARRANGEMENT OF EQUIPMENT FOR MOVEMENT ON WATER

1 - splash panel; 2 - splash panel control cock; 3 - pneumatic cylinder of splash panel; 4 - signal lamp of rear door locking mechanism; 5 - control panel; 6 - vision device ТНПО-350Б; 7 - engine protection valve control handle; 8 - front water drainage pump; 9 - cover of engine compartment bulkhead hole providing access to air cleaner shutter knob; 10 - drive of compresser and middle water drainage pump; 11 - stopper; 12 - compressor; 13 - non-return valve of water drainage pump outlet pipeline; 14 - buoy; 15 - handle of preheater exhaust gas hole cover; 16 - ejector drain valve; 17 - air intake pipe; 18 - handwheel of rear door locking mechanism; 19 - guide vanes; 20 - rear door limit switches; 21 - valve to drain water from rear section of hull; 22 - rear door locking mechanism; 23 - rear water drainage pump; 24 - electric motor of water drainage pump; 25 - pneumatic cylinder of air cleaner dust suction ejector valve; 26 - cover of engine compartment bulkhead access hole; 27 - intake screen of water drainage pump; 28 - middle water drainage pump; 29 - side fender; 30 - by-pass valve to drain water from driving compartment to engine compartment; 31 - engine protection valve switch; 32 - switch of front and rear water drainage pump motors; 33 - interlocked pneumatic control cock of air intake pipe, splash panel and air cleaner dust suction ejector valve; 34 - signal lamp of engine water protection valves; 35 - track; 36 - towing wire rope; 37 - front fender

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to reduction gear case 8. The bottom face of the housing has a round port closed with screen 11 which is attached to flange 2. The pump sucks air from the vehicle hull through this port. Provided on the housing side is outlet cast branch pipe 18. The impeller having radial curved blades is secured by means of a key and bolt 5 on shaft 16. Shaft 16 which is made integral with the bevel gear rotates in two ball bearings 17.

The water is discharged by the pump through outlet pipeline 14 (Fig.299) whose one end is connected with outlet branch pipe 18 (Fig.304), and the other end is brought out to the roof of the troop compartment. To prevent the back flow of water from the outside, the upper end of the outlet pipe is fitted with non-return valve 13 (Fig.303).

Disc-type non-return valve 5 (Fig.305) is mounted in the hull of roof 3 to which water outlet pipeline 12 is connected. The valve disc is secured on rod 10 which is held in the bushing of flange 2 attached to the roof with bolts 7. Spring 8 fitted on the valve rod thrusts with its lower end against bushing 11 held by nut 9. Valve 5 opens under the action of the jet of water sucked from the vehicle hull by the pump, and closes under the action of compressed spring 8. From above, the valve is closed with armour plate 6.

Front water drainage pump 25 (Fig.8) is installed in the right-hand front section of the engine compartment. It is driven by electric pump МПВ-2 as well as the rear pump, but the electric motor is attached directly to the flange of the pump housing in the vertical position.

The front pump is similar to the rear pump both in design and operating principle. The electric motor shields hold drain pipes which connect the inner space with the atmosphere and thus prevent air leakage through the shaft seals, which may take place when the temperature and consequently the pressure change in the electric motor during its operation.

The electric motors of the front and rear pumps are started by switches 6 and 7 (Fig.246) WATER DRAINAGE (ОТКАЧКА ВОДЫ) on the central panel.

The middle water drainage pump (Fig.306) is driven by the engine through the compressor. It is made as a single unit with the compressor and located in the engine compartment behind the engine.

The pump consists of housing (volute) 2, impeller 10, drive shaft 4 with bevel gear 7, self-tightening cups 3 and water filtration screen 11.

The aluminum-cast housing is attached with its upper flange to the reduction gear case with bolts.

The housing has a round intake port closed with screen 11. Water is discharged from the pump through the tangential branch pipe of the pump housing, pipeline and non-return valve.

Axial impeller 10 of the pump having radial curved flanges is key-fitted on the end of shaft 4.

Shaft 4 rotates in ball bearings 6; it is driven by bevel gear 7 which is meshed with the bevel gear of the compressor drive.

Water is discharged from the driving compartment through water drain valve 17 (Fig.15) mounted in the bulkhead of the engine compartment. Valve 2 (Fig.307) represents a shaped plate secured by pin 11 on handle 4. The latter is secured on axle 3 which holds spring 12 pressing the valve to the seat. The valve is fixed in an open position by lock 6 whose end enters the hole of the bracket strap. Valve assembly 2 is mounted on pedal bridge bracket 8. To open the valve, press the end of handle 4 to the engine compartment bulkhead till the lock enters the hole, and to close the valve, pull lock ring 7.

14.4 CARE OF EQUIPMENT

Care of the equipment includes the following operations:

- regular inspections of the gaskets under the covers and plugs of the bottom, hull and turret, (to make sure that they are present and sound);

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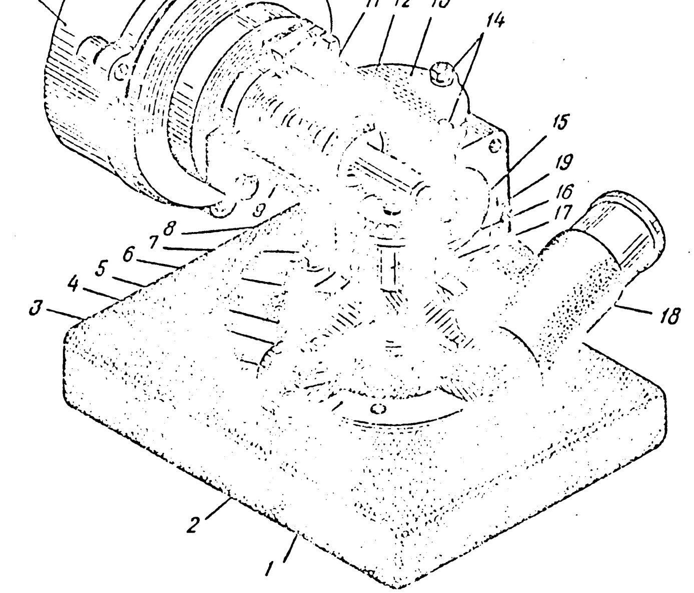

FIG.304. REAR WATER DRAINAGE PUMP

1 - intake screen of water drainage pump; 2 - pump securing flange; 3 - pump housing; 4 - pump impeller; 5 - impeller securing bolt; 6 - self-tightening cup; 7 - pump-to-reduction gear securing stud; 8 - reduction gear case; 9 - key; 10 - electric motor; 11 - motor shaft; 12 - drive bevel gear; 13 - reduction gear cover; 14 - cover securing nut; 15 - toothed coupling of smoke-generating system pump; 16 - shaft of water drainage pump impeller, 17 - ball bearing; 18 - branch pipe to discharge water from pump; 19 - flange to secure pump of smoke-generating system

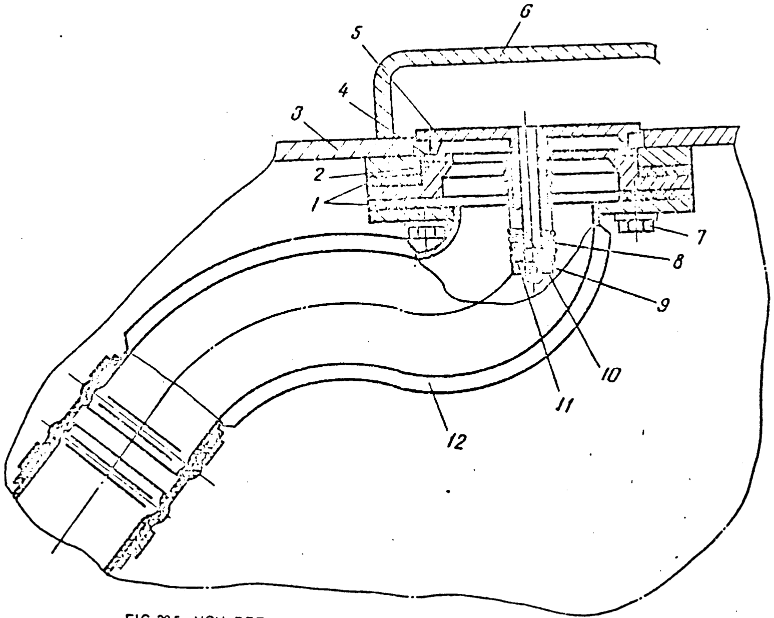

FIG.305. NON-RETURN VALVE OF WATER DRAINAGE PUMP

1 - gaskets; 2 - flange; 3 - hull roof; 4 - rubber seat of valve; 5 - non-return valve; 6 - armour plate; 7 - pipe securing bolt; 8 - valve spring; 9 - rod nut; 10 - valve rod; 11 - bearing bushing; 12 - outlet pipeline

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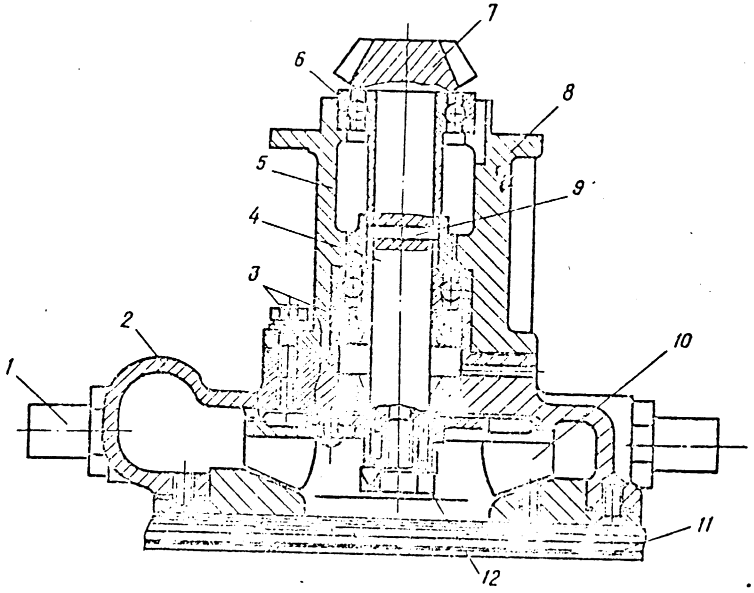

FIG.306. MIDDLE WATER DRAINAGE PUMP DRIVEN FROM COMPRESSOR

1 - trunnion; 2 - pump housing; 3 - self-tightening cups; 4 - pump drive shaft; 5 - drive case; 6 - shaft ball bearing; 7 - drive gear; 8 - pump-to-reduction gear attachment flange; 9 - pin; 10 - pump impeller; 11 - water filtration screen; 12 - impeller nut

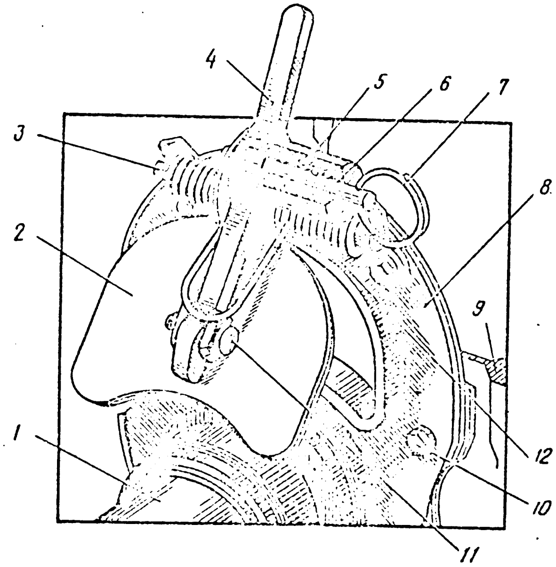

FIG.307. DRIVING COMPARTMENT-TO-ENGINE COMPARTMENT WATER BY-PASS VALVE

1 - pedal bridge; 2 - by-pass valve; 3 - valve handle axle, 4 - valve handle; 5 - lock spring; 6 - lock; 7 - lock ring ;8 - pedal bridge bracket; 9 - engine compartment bulkhead; 10 - bracket securing bolt; 11 - valve securing pin; 12 - valve spring

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cleaning the latter;

- cleaning the intake screens of the water drainage pumps and non-return valves from dirt;
- checking the rear door gaskets and locking mechanisms;
- regular cleaning of vision device ТНПО-350Б;
- checking the engine protection valve control cables for proper tension and the valves for serviceability;
- checking the mechanisms serving to draw out the air supply pipe and to raise the splash panel;
- checking the lubricant level in the case of the water drainage pump reduction gear and replenishing the latter.

Check the lubricant level in the case of the rear water drainage pump reduction gear and add lubricant every 8000-9000 km of run as follows:

(a) Open the rear doors.

(b) Open the right-hand cover of the battery compartment access hole.

(c) Unscrew four nuts 14 (Fig.304) securing cover 13 of the water drainage pump reduction gear and take off the cover.

(d) Check amount of lubricant in the reduction gear case. The lubricant level must reach the axis of bevel gear 12. If the amount of lubricant is insufficient, add grease ЦИАТИМ-201.

(e) Reinstall the cover and secure it.

(f) Close the battery compartment.

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15. PNEUMATIC SYSTEM

15.1. PURPOSE AND COMPONENTS

The pneumatic system (Fig.308) is designed to feed compressed air to:

- engine air starting system;
- air-and-liquid cleaning system of the vision devices;
- splash panel, air intake pipe and air cleaner dust suction valve control system;
- stopping brake duplicating pneumatic control;
- engine clutch release duplicating control.

The pneumatic system includes compressor 33, cylinder 35, air pressure control unit 1 three air pressure-reducing valves 7 and 42, oil-and-moisture separator 13, three air filters, oil settler 15, three electropneumatic valves 36, 37 and 44, control valves 39, 41 and 45, adaptor boxes 9 and 46, four pneumatic cylinders 2, 24 and 27, pressure gauge 47, non-return valves 10 and 21, pipelines and fittings.

15.2. DESIGN

The compressor (Fig.309) is driven from the engine power take-off shaft through the driving shaft (Fig.310), belt drive and reduction unit. The power take-off shaft rotates i two ball bearings 8 held in case 6 which is bolted to the cylinder block-and-crankcase un One end of shaft 4 is meshed through outer splines with the splines of the engine power t off shaft, and other end carries drive pulley 1 of the belt drive; the pulley is pressed b nut 2 to locking ring 11. The bearings of shaft 4 are filled with oil through the hole closed with plug 3. The movement is transmitted from the drive pulley to driven pulley 21 (Fig.309) through two belts. The belt tension is adjusted with the use of pulley 17 by tu ing turnbuckle 19.

Rotation from driven pulley 21 is imparted to shaft 7 (Fig.311) and gear 9 and then to water drainage pump 16 and fan. Driving shaft 7 rotates the eccentric shaft of the com sor through a coupling. The reduction unit of the compressor is attached to the vehicle bottom through three supports; the latter enable the adjustment of the reduction unit pos tion and consequently the elimination of the drive belt misalignment.

The reduction unit consists of case 11, driving shaft 7 with bevel gear 9, pulley 4, driven gears of the fan and water drainage pump with shafts, and compressor drive couplin

The case of the reduction unit carries all the components of the latter. It represen a casting with three flanges to which the housings of the compressor, water drainage pu p and fan are attached.

15.2.1. Compressor

The compressor (Fig.312) is the source of compressed air for pneumatic system. Compr sor AK-150CMB is of a two-cylinder, three-stage air-cooled piston type. The operating pre sure produced by the compressor is equal to 150 kgf/cm^2.

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Inset 14

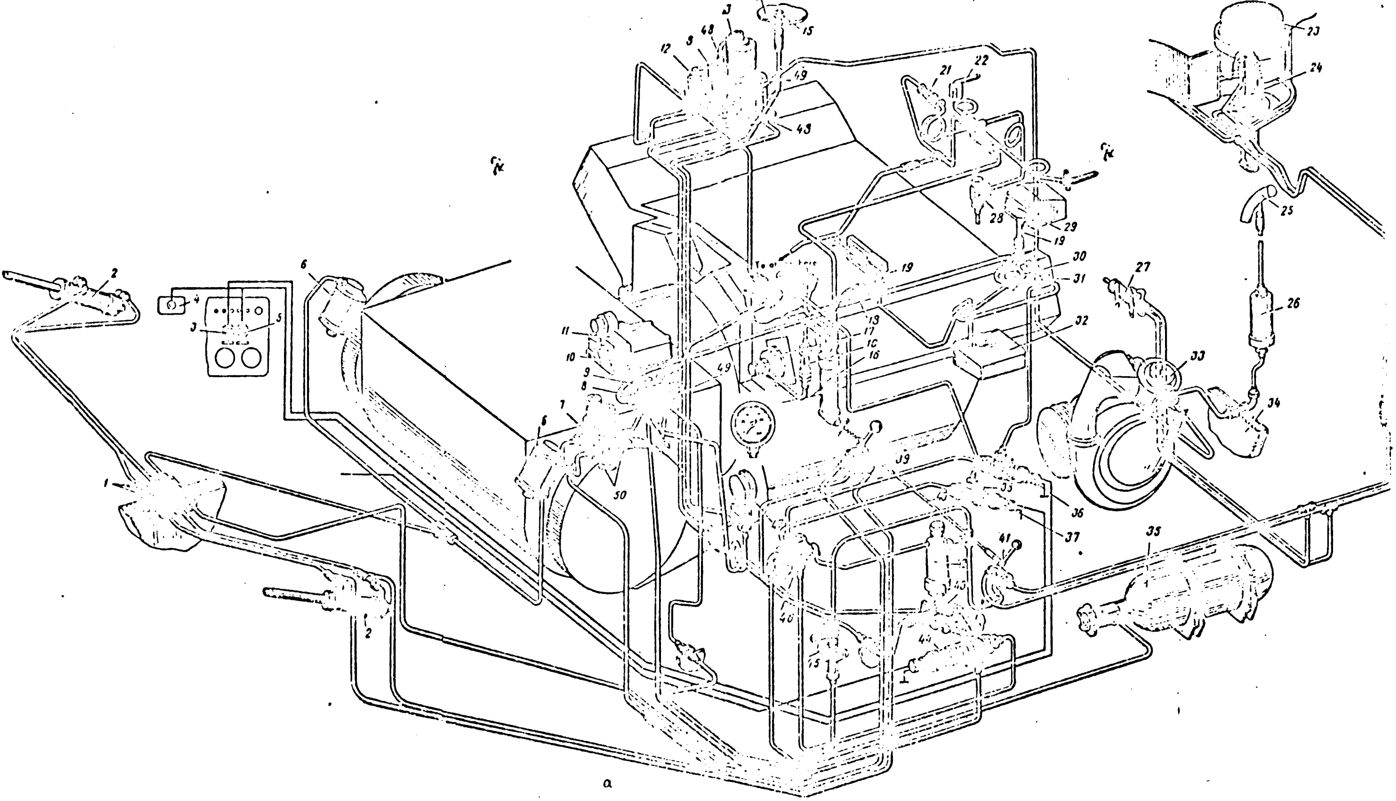

FIG.323. PNEUMATIC SYSTEM

a - general view; b - diagram; 1 - pipeline sleeves; 2 - pneumatic cylinders of splash panel, 3 - button of electropneumatic valve of engine air starting system; 4 - button of electropneumatic valve of commander's vision device air-and-liquid cleaning system (on central panel), 5 - button of electropneumatic valve of driver's vision device air-and-liquid cleaning system, 6 - stopping brake boosters, 7 - air pressure relieving valves (150±70 kgf/cm²); 8 - air filters; 9 - ejector box; 10 - non-return valves; 11 - valve box of power transmission hydraulic control system, 12 - air pressure control unit; 13 - oil-and-moisture separator; 14 - hull roof, 15 - nozzle to discharge condensate from pneumatic system; 16 - oil settler; 17 - engine air distributor; 18 - pipe union to charge cylinder from external compressed air source; 19 - nozzle of air-and-liquid cleaning system; 20 - driver's vision device; 21 - valves to scavenge injectors of smoke-generating system; 22 - injectors of smoke-generating system; 23 - air intake pipe; 24 - pneumatic cylinder of air intake pipe; 25 - air pipeline of filter-ventilating unit, 26 - compressor air filter, 27 - pneumatic cylinder of air cleaner dust suction ejector valve; 28 - non-return valve of smoke-generating system; 29 - commander's vision device; 30 - shut-off cock of air-and-liquid cleaning system; 31 - ejector of air-and-liquid cleaning system, 32 - tank of air-and-liquid cleaning system; 33 - compressor; 34 - engine compartment bulkhead; 35 - air cylinder; 36 - electropneumatic valve of air-and-liquid cleaning system; 37 - electropneumatic valve of engine air starting system; 38 - electropneumatic valve manual control lever; 39 - splash panel control cock; 40 - control rod of interlocked pneumatic control; 41 - air intake pipe and air cleaner dust suction ejector valve control cock; 42 - air pressure reducing valve (150±14 kgf/cm²); 43 - ejector condensate discharge cock of oil-and-moisture separator; 44 - electropneumatic valve of stopping brake pneumatic control; 45 - cock of engine clutch release pneumatic control, 46 - adapter box; 47 - cylinder pressure gauge; 48 - union nuts; 49 - air filter collar; 50 - pipeline-to pressure reducing valve securing nuts; 51 - jet of drain pipeline of smoke-generating system; 52 - pressure warning unit ДЗУ-6 of stopping brake pneumatic control system; 53 - limit switch of stopping brake pneumatic control

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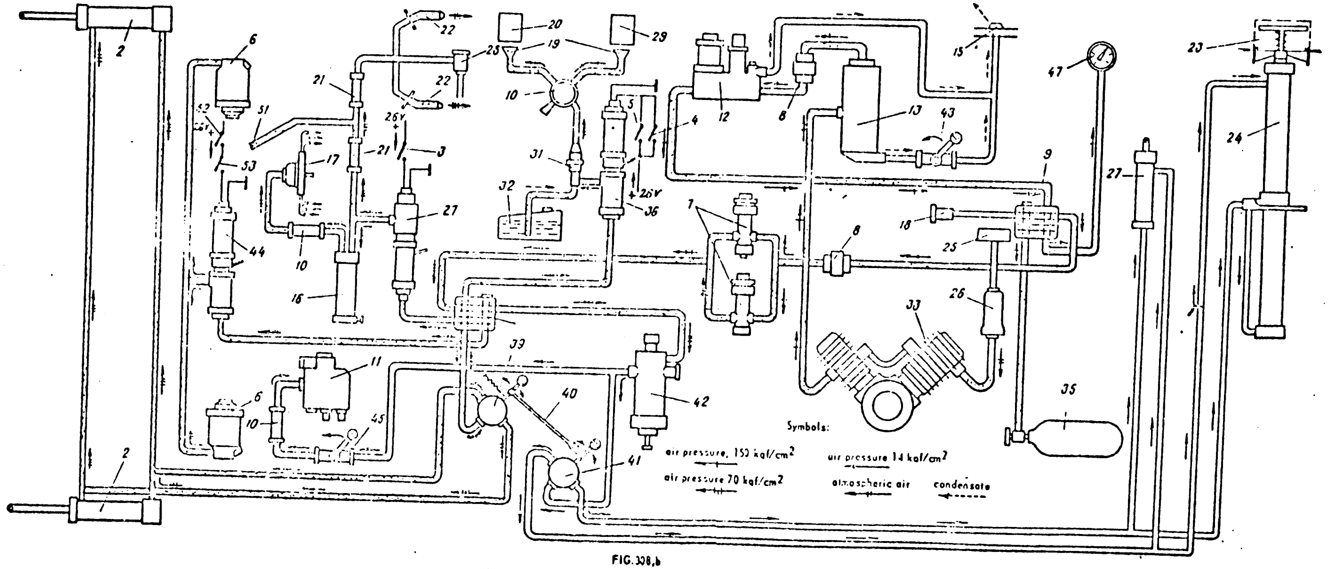
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2
6
6
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51
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26V
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19
29
31
32
5
4
26V
36
12
8
8
13
43
15
7
9
18
25
26
33
35
47
27
24
23
11
45
39
40
41
42
Symbols:
air pressure, 150 kgf/cm²
air pressure 70 kgf/cm²
air pressure 14 kgf/cm²
atmospheric air
condensate

FIG. 308,b

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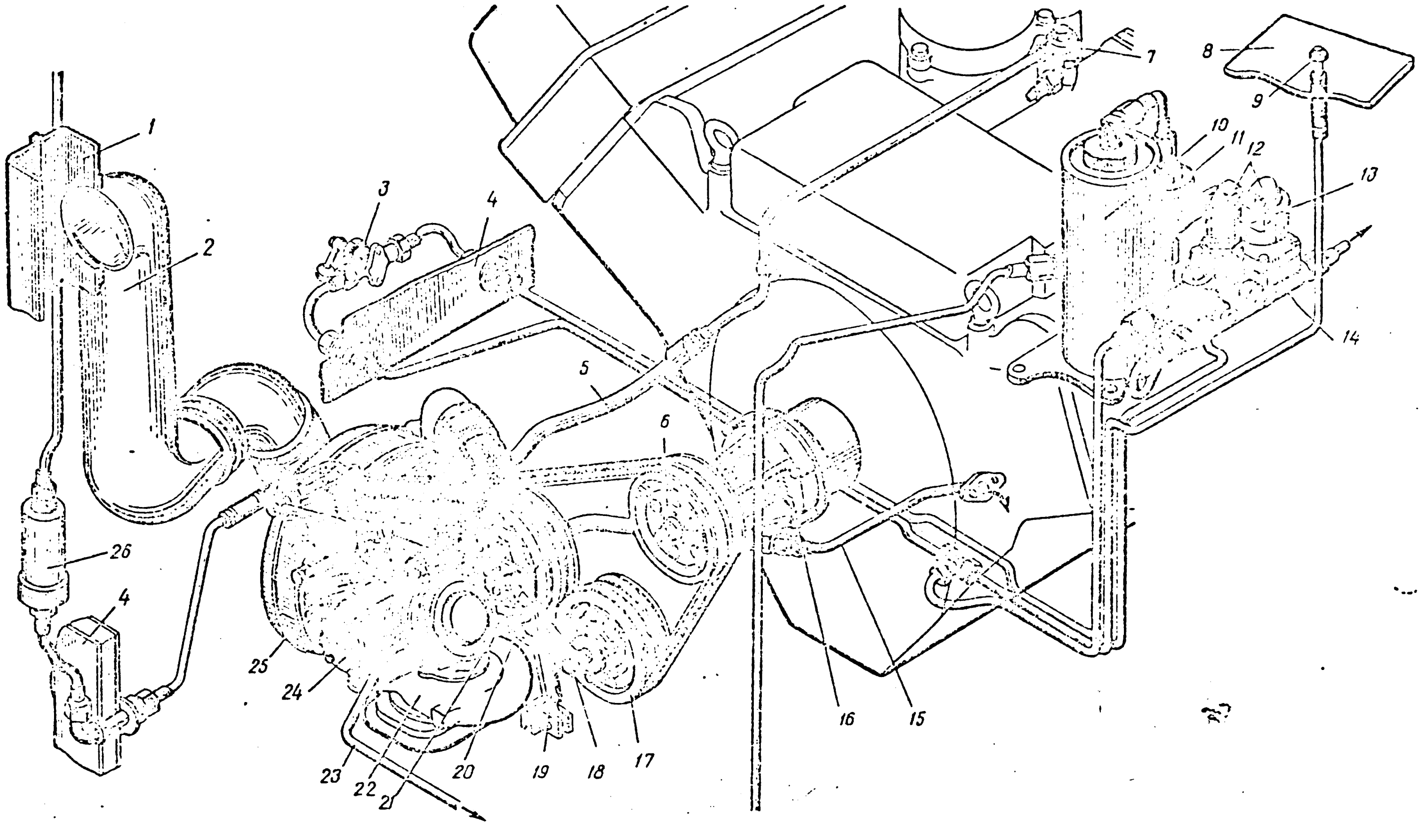

FIG.209. COMPRESSOR PLANT

1 - pocket of air duct; 2 - pipeline to supply air to compressor fan; 3 - condensate discharge cock of oil-and-moisture separator; 4 - engine compartment bulkhead; 5 - pipeline to feed oil to compressor plant; 6 - drive pulley; 7 - pipeline to feed oil from engine lubricating system to compressor; 8 - vehicle roof; 9 - condensate discharge nozzle; 10 - oil-and-moisture separator; 11 - air filter; 12 - rubber valves; 13 - securing bracket; 14 - pressure control unit; 15 - compressor-to-engine crankcase oil pipeline; 16 - drive shaft; 17 - pulley of compressor drive belt tension adjusting mechanism; 18 - lever of belt tension adjusting mechanism; 19 - turnbuckle of belt tension adjusting mechanism; 20 - coupling pin; 21 - driven pulley; 22 - water drainage pump; 23 - pipe to supply compressed air to pressure control unit; 24 - compressor; 25 - compressor fan; 26 - air filter

[redacted]

The compressor output at the shaft speed of 2000±50 rpm is equal to 2.4 m^3/hr.

The compressor is made as a single unit with the fan and water drainage pump and is attached with flange 18 to the reduction unit.

The compressor consists of housing 4, 1st and 2nd stage cylinder 14, head 11 of the 1 and 2nd stage cylinder, 3rd stage cylinder 25, eccentric shaft 19 rotating in ball bearing main connecting rod 17 and articulated connecting rod 22, 1st and 2nd stage piston 13 and 3rd stage piston 24, suction valves 12 and 2 and delivery valves 6 and 8, pipelines, pipe unions and fastening parts.

Compressor housing 4 has an intricate shape; it is cast of aluminum and composed of two bolted halves. The joint is sealed with a silk cord impregnated with a sealing compou

The housing has flanges arranged at an angle of 90°; attached to these cylinders by means of studs and nuts are cylinders 14 and 25. One of the other two flanges is closed wi a blank cover, and the other flange (18) is attached to the case of the compressor reducti unit.

The cylinders cast of aluminum alloy have a stepped boring. The bore of the 1st and 2nd stage cylinder is smaller at the bottom than on top, while the bore of the 3rd stage cylinder is smaller on top than at the bottom.

Concentric ribs provided on the outer surface of the cylinders serve for better cooli Thin-walled steel liners 15 inserted in the cylinders have two diameters: the 1st and 2nd stage cylinder has a through boring. The 3rd stage cylinder has bottom 26. The 1st and 2nd stage cylinder has head 11 attached by means of studs and closed with cover 9. The head i corporates a valve assembly and has branch pipe 10 through which air is supplied to the compressor.

Two bosses provided on the side surface of the 3rd stage cylinder have threaded holes for the suction and delivery valves.

The stepped pistons are made from aluminum alloy. Four grooves provided on the head o the 1st and 2nd stage piston serve to receive compression rings sealing the 1st stage cylinder, and four grooves provided on the skirt to receive compression rings, sealing the 2nd stage cylinder. A groove made just at the edge of the skirt holds an oil control ring The 3rd stage piston has five compression rings and one oil control ring and on the skirt has seven compression rings and one oil control ring. All the piston rings are made from iron.

The 3rd stage piston has no head. In the 3rd stage air is compressed inside circula space A formed by the cylindrical surface of the piston and side surface of the cylinder when the piston moves up (towards bottom 26). As the piston moves back the volume of space increases.

In the 2nd stage air is compressed inside the same space, the only difference being that compression takes place when the piston moves down.

Cast bosses provided on the skirt have holes for pins 16 and 23. Press-fitted into th holes are bronze bushes.

The crank gear serves to transfer the rotary motion of eccentric shaft 19 into the reciprocating movement of the pistons.

It includes eccentric shaft 19, two connecting rods 17 and 22, webs with poises, and retainer.

The eccentric shaft rotates in two ball bearings 20 mounted in case 4. A retainer pressed into the big end of main connecting rod 17 rests on needle bearing 21 fitted on th middle portion of shaft 19.

The big end of the articulated connecting rod slides over the outer surface of the retainer.

The small ends of the connecting rods are joined with the pistons by means of piston pins 16 and 23. The piston pins are hollow. The pins are stopped with aluminum end caps wh do not let the pins scrape the cylinder face.

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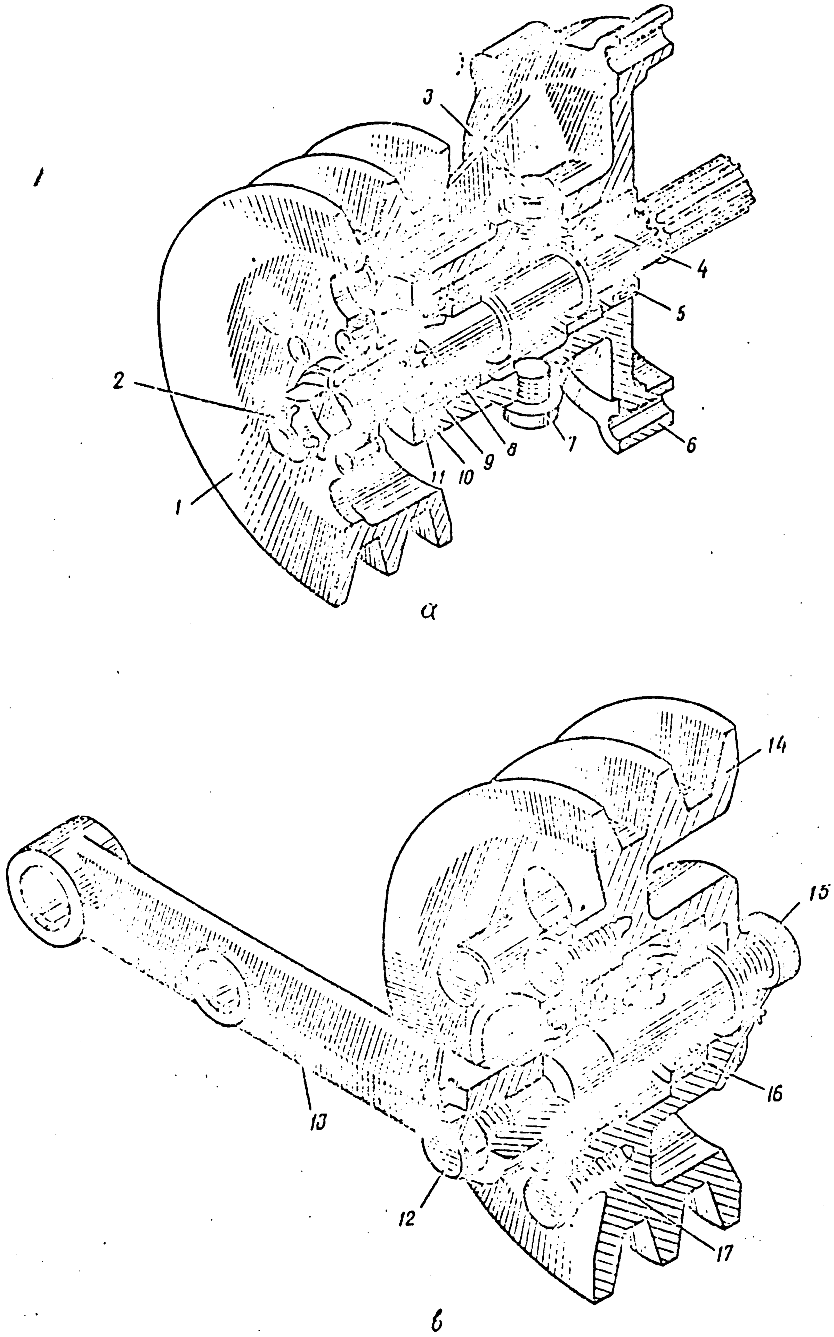

FIG.310. COMPRESSOR DRIVING SHAFT
a - driving shaft; b - tension pulley; 1 - drive pulley; 2 - nut; 3 - filler plug; 4 - power take-off shaft; 5 - self-tightening cup; 6 - power take-off shaft case; 7 - level plug; 8 - ball bearing; 9 - self-tightening cup; 10 - shims; 11 - locking ring; 12 - level plug of tension pulley; 13 - lever of belt tension adjusting mechanism; 14 - tension pulley; 15 - filler plug; 16 - ball bearing; 17 - self-tightening cup

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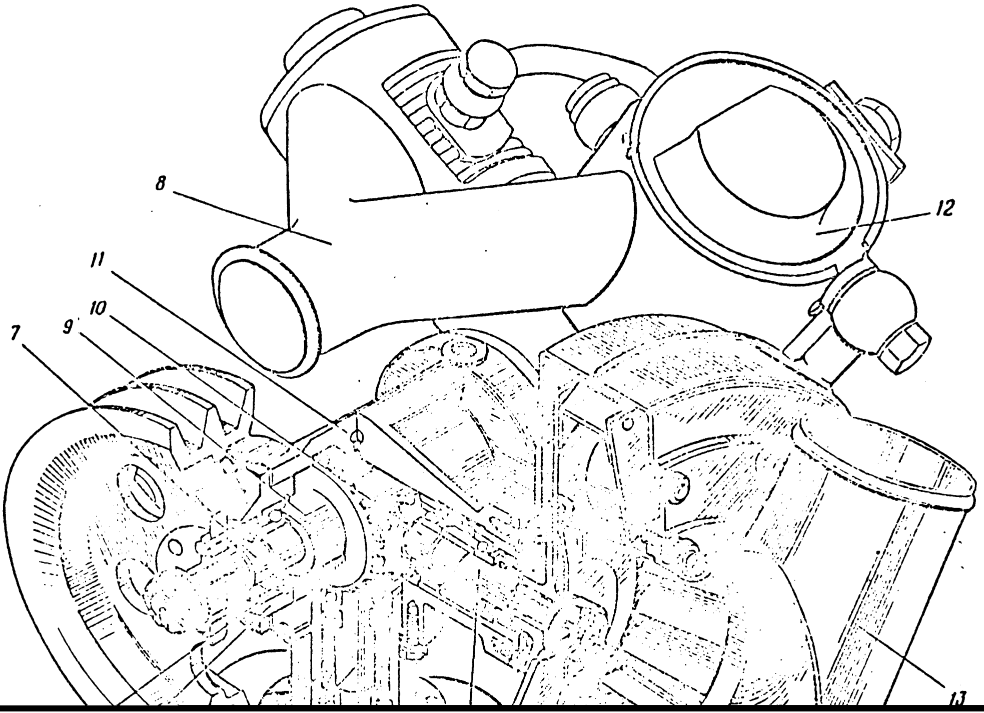
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12
13

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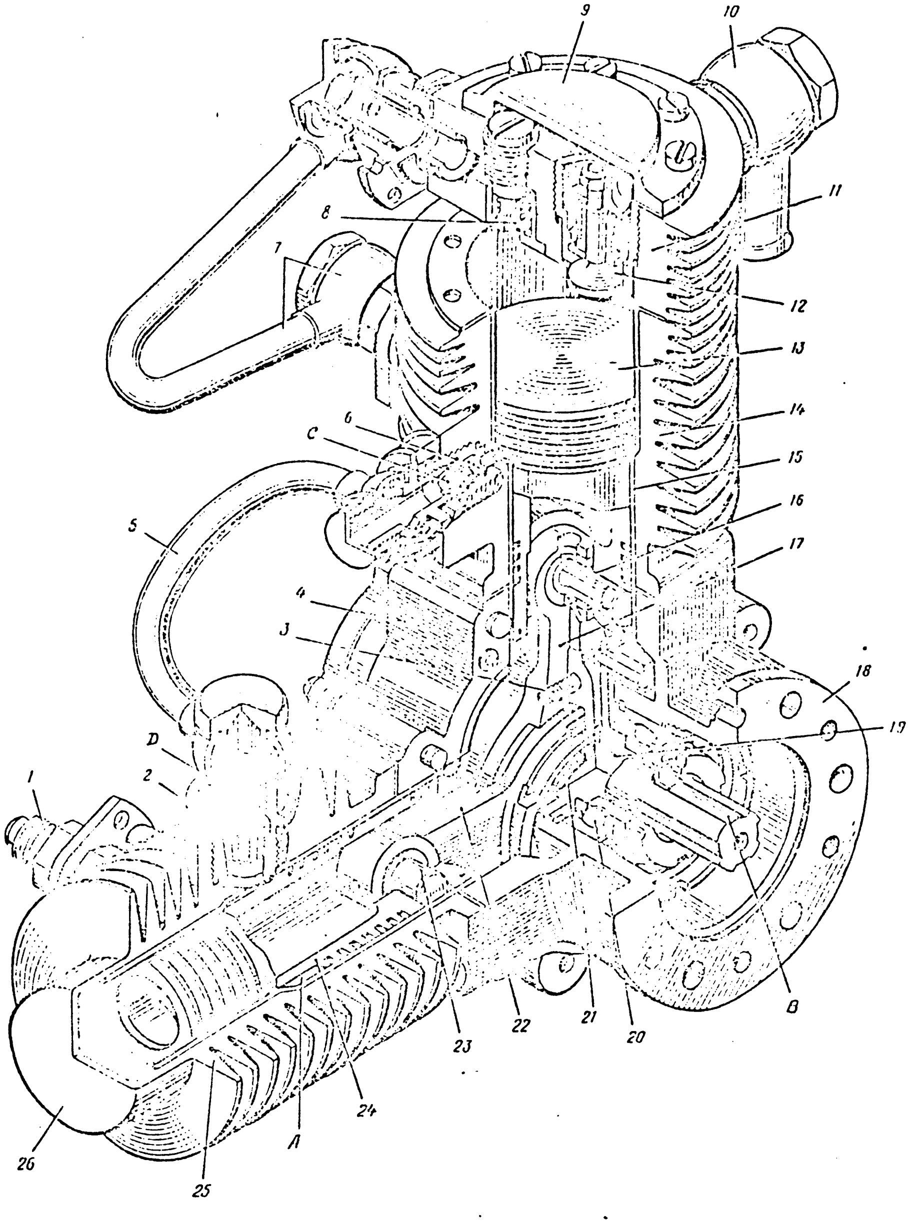

FIG.312. COMPRESSOR

1 - pipe union of 3rd stage delivery valve; 2 - 3rd stage suction valve; 3 - screw; 4 - compressor housing; 5 - 2nd stage-to-3rd stage pipeline; 6 - 2nd stage delivery valve; 7 - 1st stage-to-2nd stage pipeline; 8 - 1st stage delivery valve; 9 - cylinder head cover; 10 - 1st stage air supply branch pipe; 11 - 1st and 2nd stage cylinder head; 12 - 1st stage suction valve; 13 - 1st and 2nd stage stepped piston; 14 - 1st and 2nd stage piston; 15 - cylinder liner; 16 - 1st and 2nd stage piston pin; 17 - main connecting rod; 18 - compressor housing flange; 19 - eccentric shaft; 20 - ball bearing; 21 - needle bearings; 22 - articulated connecting rod; 23 - pin of articulated connecting rod; 24 - 3rd stage stepped piston; 25 - 3rd stage cylinder; 26 - 3rd stage cylinder bottom; A - 3rd stage compression space; B - splines; C - end piece of delivery valve; D - suction valve spring

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The eccentric shaft end has splines "B" which are meshed with the drive shaft of the compressor through a splined coupling.

Pipeline 7 connects the cylinders of the 1st and 2nd stages, while pipeline 5, the cylinders of the 2nd and 3rd stages.

The pipe unions of pipeline 5 mount 2nd stage delivery valve 6 and 3rd stage suction valve 2. Flat delivery valve 6 having cone "B" is pressed to the seat by a spring. Disc suction valve 2 is pressed to the seat by spring "D".

Compressed air is discharged from the compressor through pipe union 1 holding the 3rd stage delivery valve.

Fan 25 (Fig.309) serves to blow off the compressor. It has a two-disc impeller secured on the splined portion of shaft 17 (Fig.311). The impeller is mounted in housing 14 (volute) having inlet branch pipe 13 and outlet branch pipe 8.

The outlet branch pipe serves to blow off the compressor.

The compressor operation (Fig.313) boils down to the following:

With the engine running, rotation is transmitted from the crankshaft to the compressor drive shaft through the power take-off shaft and belt drive; then, the rotation is imparted through a coupling to eccentric shaft 13 which puts connecting rods 12 and 14 into reciprocating motion.

When 1st and 2nd stage piston 15 moves down, a rarefaction is created in space "A" over the piston; under the effect of rarefaction, suction valve 2 opens and admits air from the air cleaner to the cylinder. With piston 15 moving up, air is compressed (1st stage), and suction valve 2 closes. When the pressure reaches a value exceeding the effort of the delivery valve spring, the delivery valve opens and admits air to the space over suction valve 16 through pipeline 17 and holes "D". Under the action of air pressure, the suction valve opens, and air passes through ports "C" and fills the circular space formed between cylinder (larger bore) and piston 15 (at the smaller diameter), with the latter rising; this space is located between the upper and lower compression rings.

When the 1st and 2nd stage piston moves down, the volume of the circular space decreases, and the air pressure rises (2nd stage). Under the action of the high pressure, suction valve 16 closes. When the pressure reaches the predetermined value, 2nd stage delivery valve 5 opens and air passes through pipeline 6 to circular space "B" of the 3rd stage cylinder, thus opening suction valve 7. As piston 10 moves up, the air is compressed further. At a pressure of 150 kgf/cm^2 the air opens delivery valve 9 and enters the pipeline running to the oil-and-moisture separator; then, the air flows through a distributing box to the cylinder.

15.2.2. Cylinder

The cylinder (Fig.314) serves to store compressed air and to start the engine. It is arranged in the driving compartment at the left side of the hull and attached with two collars to the vehicle bottom.

The cylinder has a 5-lit capacity and is fitted with a narrow neck whose taper thread receives a shut-off valve.

The valve assembly consists of body 2, valve 3, spring 4, diaphragm 5, ball 6 and a knob fitted on the square end of stem 7 screwed into plug 8.

When the knob is screwed on as far as it can go, the stem presses valve 3 to the seat through ball 6 and diaphragm 5, thus cutting off the air discharge.

The diaphragm prevents air leakage through the valve.

With the engine running, the shut-off valve must be opened, in order to keep the cylinder charged.

To make it possible to charge the cylinder from an external source of compressed air, provision is made for pipe union 18 (Fig.303) fitted on the end of the pipeline connected to

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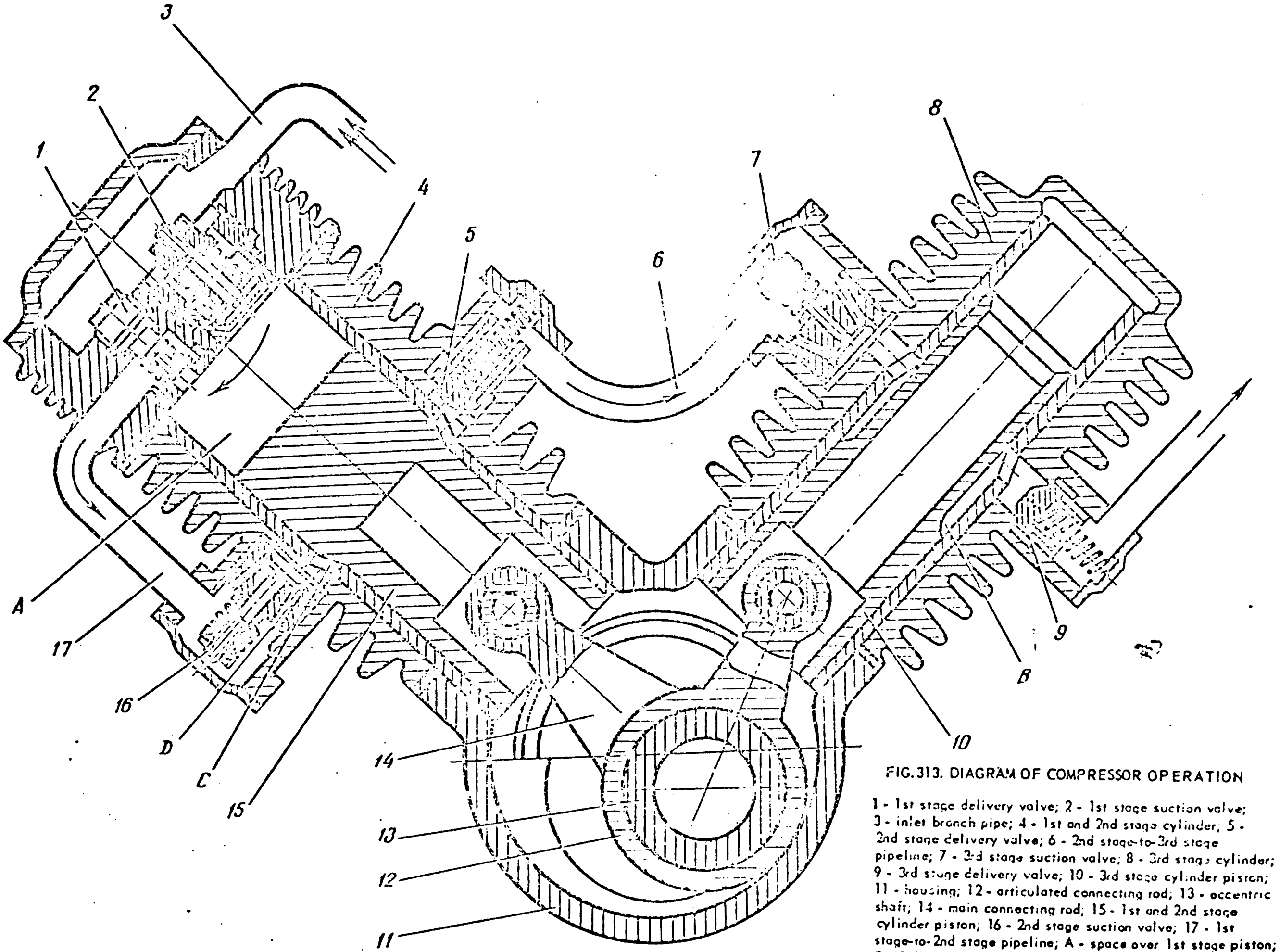

FIG. 313. DIAGRAM OF COMPRESSOR OPERATION

1 - 1st stage delivery valve; 2 - 1st stage suction valve; 3 - inlet branch pipe; 4 - 1st and 2nd stage cylinder; 5 - 2nd stage delivery valve; 6 - 2nd stage-to-3rd stage pipeline; 7 - 3rd stage suction valve; 8 - 3rd stage cylinder; 9 - 3rd stage delivery valve; 10 - 3rd stage cylinder piston; 11 - housing; 12 - articulated connecting rod; 13 - eccentric shaft; 14 - main connecting rod; 15 - 1st and 2nd stage cylinder piston; 16 - 2nd stage suction valve; 17 - 1st stage-to-2nd stage pipeline; A - space over 1st stage piston; B - 3rd stage compression space; C - ports; D - drilled holes

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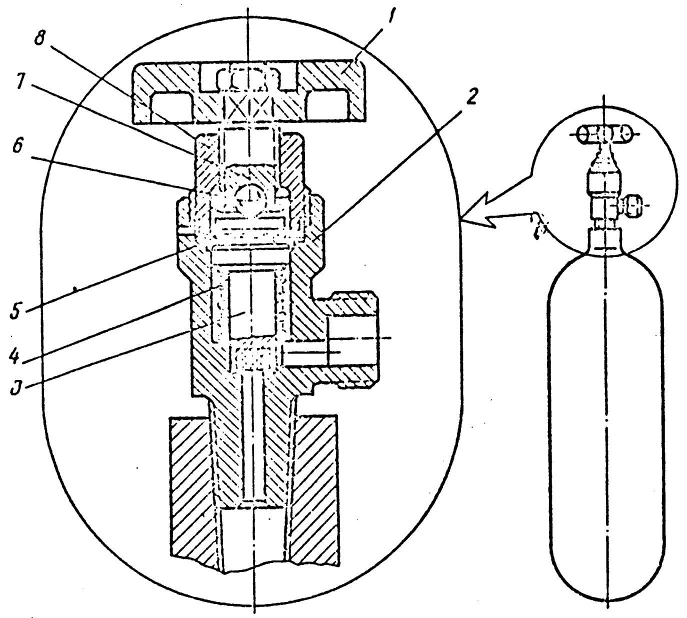

FIG. 314. COMPRESSED AIR CYLINDER
1 - knob; 2 - knob body; 3 - valve; 4 - spring; 5 - diaphragm; 6 - ball; 7 - stem; 8 - plug

adapter box 9. The pipe union is closed with a plug. For charging the cylinder from an external source of compressed air, unscrew the plug and connect the dispensing hose to the pipe union.

15.2.3. Air Pressure Control Unit АДУ-2С

Air pressure control unit АДУ-2С (Fig.315) serves to automatically control the pressure in the cylinder. It either switches on the compressor for charging the cylinder, or changes it over to an idle run.

Air pressure control unit АДУ-2С is arranged in the right-hand bay of the engine compartment.

Air pressure control unit consists of body 8, idle valve 1, cut-off valve 2, actuating valve 5, diaphragm 6 and non-return valve 7. The body has an intricate shape and threaded vertical and horizontal holes to receive sleeves with the valves and springs, and pipe unions. The pipeline running from the compressor is connected to pipe union 9, and the pipeline running to the pneumatic system is connected to pipe union 11.

The air pressure control unit functions as follows.

With the cylinder charged to capacity (the pressure is equal to 150 kgf/cm^2), non-return valve 7 and actuating valve 5 are kept closed by the air pressure applied from the cylinder to pipe union 11, diaphragm 6 is deflected upward, and cut-off valve 2 is kept open, and the air escapes from the compressor into the atmosphere through pipe union 9 and open valve 2.

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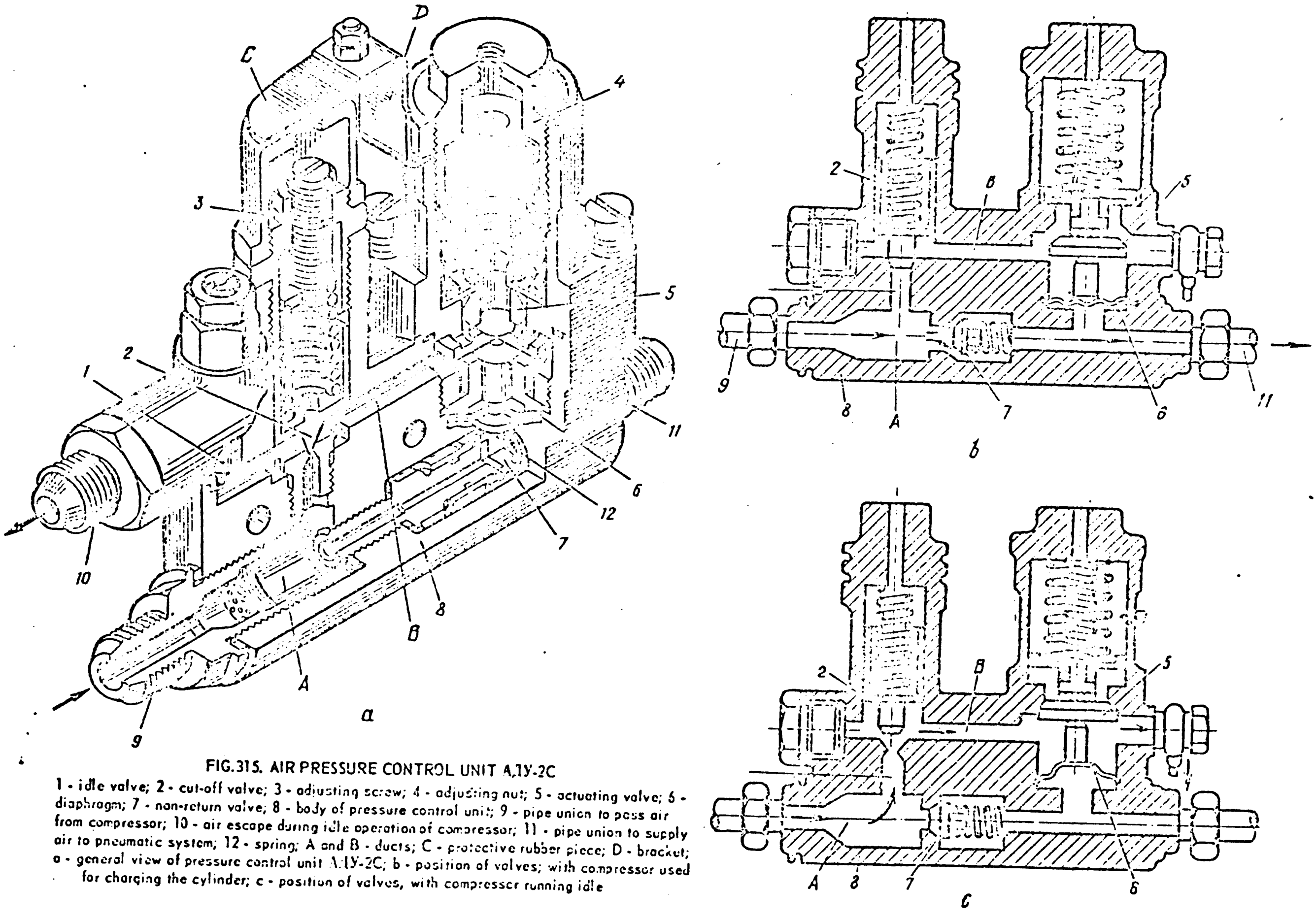

FIG.315. AIR PRESSURE CONTROL UNIT АДУ-2С

1 - idle valve; 2 - cut-off valve; 3 - adjusting screw; 4 - adjusting nut; 5 - actuating valve; 6 - diaphragm; 7 - non-return valve; 8 - body of pressure control unit; 9 - pipe union to pass air from compressor; 10 - air escape during idle operation of compressor; 11 - pipe union to supply air to pneumatic system; 12 - spring; A and B - ducts; C - protective rubber piece; D - bracket; a - general view of pressure control unit АДУ-2С; b - position of valves; with compressor used for charging the cylinder; c - position of valves, with compressor running idle

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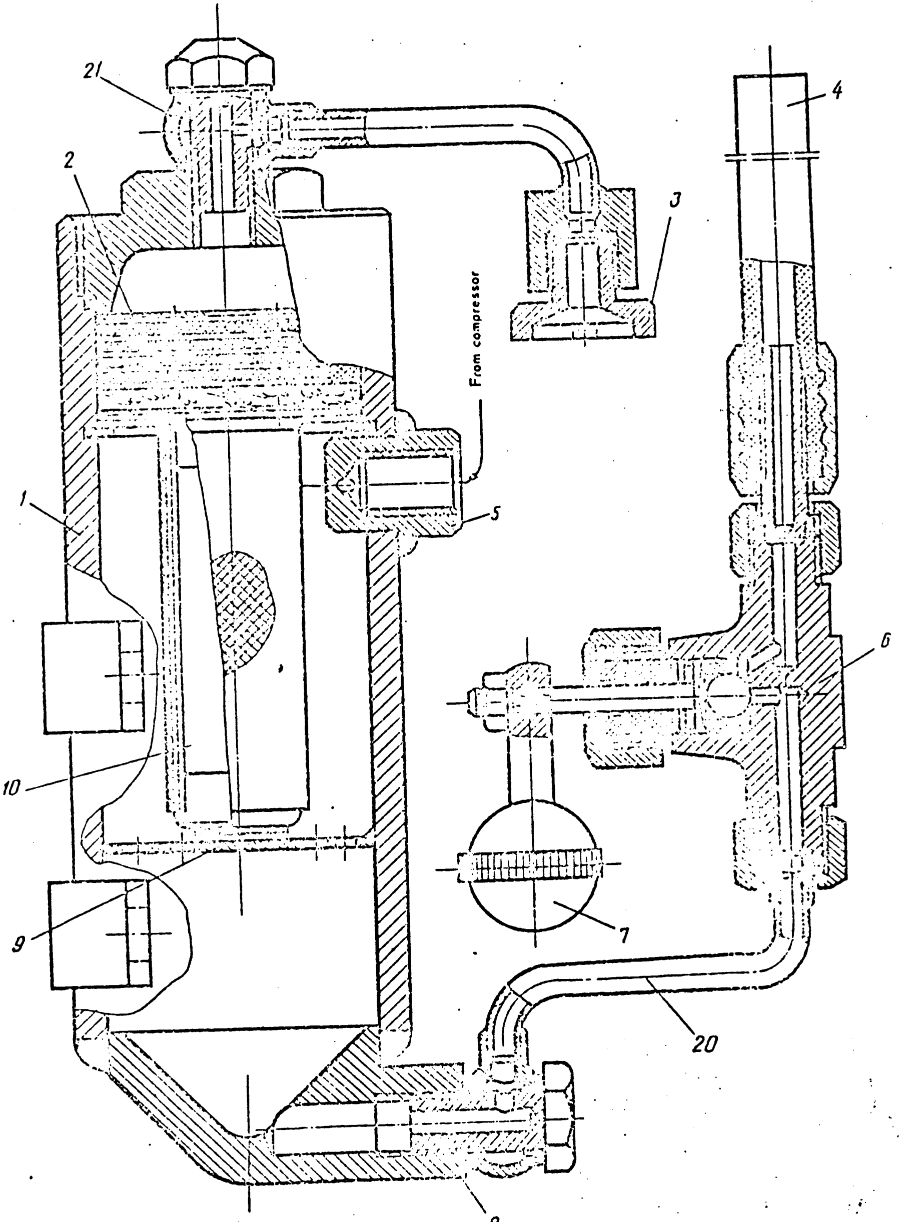
21
2
3
4
From compressor
1
5
6
10
9
7
20
8

a

[redacted]

When the pressure in the cylinder decreases down to 128-134 kgf/cm^2, diaphragm 6 straightens out, and valve 5 is opened by the spring. As a result, duct "B" communicates with the atmosphere, the pressure in the duct decreases, and valve 2 closes under the action of the spring, thus disconnecting duct "A" from the atmosphere. In this case, the compressed air delivered by the compressor opens the non-return valve and enters the cylinder.

When the pressure in the cylinder reaches 148-156 kgf/cm^2, diaphragm 6 deflects upward again, valve 5 closes, and duct "B" is disconnected from atmosphere; actuated by the air pressure, valve 2 opens duct "A". Air passes through ducts "A" and "B" and the idle valve enters the pipelines and escapes into the atmosphere via condensate discharge nozzle 15 (Fig.308). As the area of valve 2 is considerably larger than that of the needle, the valve is held in the upper position by a pressure of 15 kgf/cm^2. In this case, non-return valve 7 is pressed to its seat, thus preventing air leakage from the cylinder.

15.2.4. Oil-and-Moisture Separator

The oil-and-moisture separator (Fig.316) serves to purify the compressed air of moisture and oil. It is mounted beside air pressure control unit АДУ-2С.

The oil-and-moisture separator consists of housing 1, gauze filter 10, felt filter 3, pipe union 5 to pass air from the compressor, pipe union to supply purified air to the air pressure control unit, pipe union 8 to drain condensate, and screen 9. Gauze filter 10 consists of a casing and metal gauze. Felt filter 3 includes alternately mounted metal screens 16, four felt plates 15 and silk cloth stretched on the last upper metal screen. From above the silk cloth is closed with a grill.

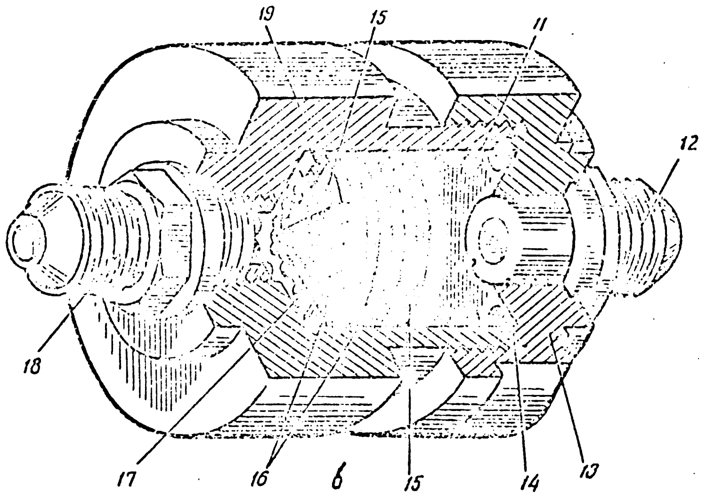

FIG.316. OIL-AND-MOISTURE SEPARATOR AND FELT AIR FILTER

a - oil-and-moisture separator; b - filter; 1 - housing; 2 - filter element of oil-and-moisture separator; 3 - felt filter; 4 - sediment drain hose; 5 - pipe union to supply air from compressor; 6 - sediment drain cock; 7 - cock handle; 8 - sediment drain pipe union; 9 - screen; 10 - gauze filter; 11 - spring; 12, 18 - pipe unions; 13 - union nut; 14 - sealing ring; 15 - felt plate; 16 - fine-mesh screens; 17 - coarse-mesh screen; 19 - filter casing; 20 - pipeline

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Air is delivered from the compressor to the housing of the oil-and-moisture separator through pipe union 5 whose hole is tangential to housing 1 and inclined down at an angle of 15°C. Owing to such a direction of the hole, the air coming out of the latter is swirled. Screen 9 and filter 10 serve to prevent spilling of the sediment and thus to protect filter element 2 from the latter. Air purified of moisture and oil, passes through filter element 2, upper pipe union having a throttling hole, pipeline, felt filter 3 and enters air pressure control unit АПУ-2С.

The throttling hole, dia. 1 mm, of the upper pipe union serves to minimize the amount of sediment drifted away when the rate of air flow sharply rises.

15.2.5. Air Filters

The air filters (Fig.317) serve to purify the air of mechanical impurities, moisture and oil. There is one gauze filter with a coarse cloth and two felt filters in the system.

The right-hand filter is mounted before the compressor and designed to purify the air passing to the compressor. It is attached to an angle bar on the engine compartment bulkhead.

The filter consists of a casing and cover 6 (screwed into the latter), filter element 2, by-pass valve 3. The filter element represents frame 7 fitted with metal screen 5 and coarse cloth bag 4 secured by means of silk twine.

The disc by-pass valve is designed to prevent stopping of air supply to the compressor when the filter element is clogged.

The air enters the filter casing through lower pipe union 9 and fills up the space between the casing and the filter element, passes through the screen and cloth and passes through the upper pipe union to the compressor. If the filter is clogged, and the resistance to air flow rises, valve 3 opens under the effect of rarefaction created by the compressor, and air flows to the compressor past the filter element.

One felt air filter 3 (Fig.316) is mounted between the oil-and-moisture separator and the air pressure control unit, and the other felt air filter, before the air reducing valve. Both filters are similar in design.

The filter consists of casing 19, union nut 13, two coarse-mesh screens 17 between which four felt plates 15 are clamped. Placed between the felt plates are fine-mesh screens 16. In the axial direction the filter element is pressed to casing 19 by spring 11.

15.2.6. Oil Settler

The oil settler (Fig.317, b) of the pneumatic system is designed to prevent penetration of oil from the air distributor to the pneumatic system. It represents cylinder (housing) 10 with cover 11 holding two pipe unions 12 and 13. A pipe union provided at the bottom of the cylinder and closed with a plug serves to drain condensate.

Welded inside the cylinder between two pipe unions is strap 14. The air coming through inlet pipe union 12, passes around the strap and only after that goes out through pipe union 13.

Abrupt change of the air stream direction results in centrifugal forces; under the effect of the latter, oil particles are thrown onto the walls of housing 10; after that the oil runs down to the housing bottom.

15.2.7. Air Pressure Reducing Valves НК-611-150/70

Air pressure reducing valves (Fig. 318) are designed to reduce the pressure of the air supplied from the compressor or cylinder to the engine air distributor, hydraulic cylinders of the stopping brakes, air-and-liquid cleaning system of the vision devices, injectors of the smoke-generating system, pneumatic cylinders of the splash panel, and also to air pressure reducing valve 42 (Fig. 308).

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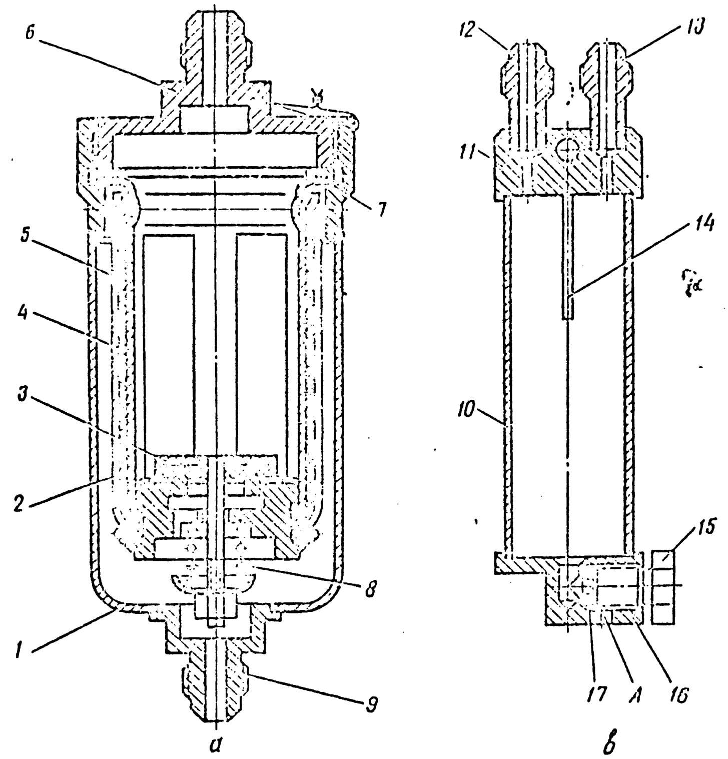

FIG. 317. AIR FILTER OF COMPRESSOR AND OIL SETTLER

a - filter; b - oil settler; 1 - filter casing; 2 - filter element; 3 - by-pass valve; 4 - coarse-cloth bag; 5 - metal screen; 6 - cover; 7 - filter element frame; 3 - valve spring; 9 - inlet pipe union; 10 - settler housing; 11 - cover; 12, 13 and 16 - pipe unions; 14 - strap; 15 - plug; 17 - gasket; A - drain hole

Both air pressure reducing valves are connected in parallel and are similar in design.

The air pressure reducing valve consists of body 15 (Fig.318), piston body 2, nut 17 with locknut 3, piston 5 with spring 4 and a rod, diaphragm 6, push rod 8, high-pressure valve 13 with spring 12, safety valve 9 and two pipe unions 7 and 14.

Metal diaphragm 6 is covered on one side with cloth, and on the other side (on push rod 8 side), with rubber. It is clamped between the shoulder of body 15 and nut 17.

Air passes from air pressure control unit АДУ-2С to space "A" over valve 13 through the distributing box and air filter; on passing through the slit between push rod 8 and housing 15, and along the slots of the push rod, the air presses diaphragm 6. The latter deflects and pushes piston 5, thus compressing spring 4. Valve 13 displaces push rod 8 under the action of spring 12, and decreases the cross-sectional area of nozzle "B"; as a result, the resistance to the air flow rises, and the pressure of the air coming out of the reducing valve through pipe union 14 decreases and remains equal to 70 kgf/cm^2.

When the air pressure decreases, diaphragm 6 deflects in the opposite direction, displacing push rod 8 together with valve 13, thus increasing the cross-sectional area of nozzle "B"; as a result, the pressure of the air coming out of the pressure reducing valve rises to 70 kgf/cm^2; as it rises further, the process is reversed, and the pressure is restored.

Safety valve 9 releases the air into the atmosphere when the pressure rises excessively due to faults of the reducing valve. It is mounted in the side pipe union of housing 15; the components of the safety valve assembly are: flat safety valve 9 with rubber plate, spring 10 and union nut 18. Air is released through the union nut hole.

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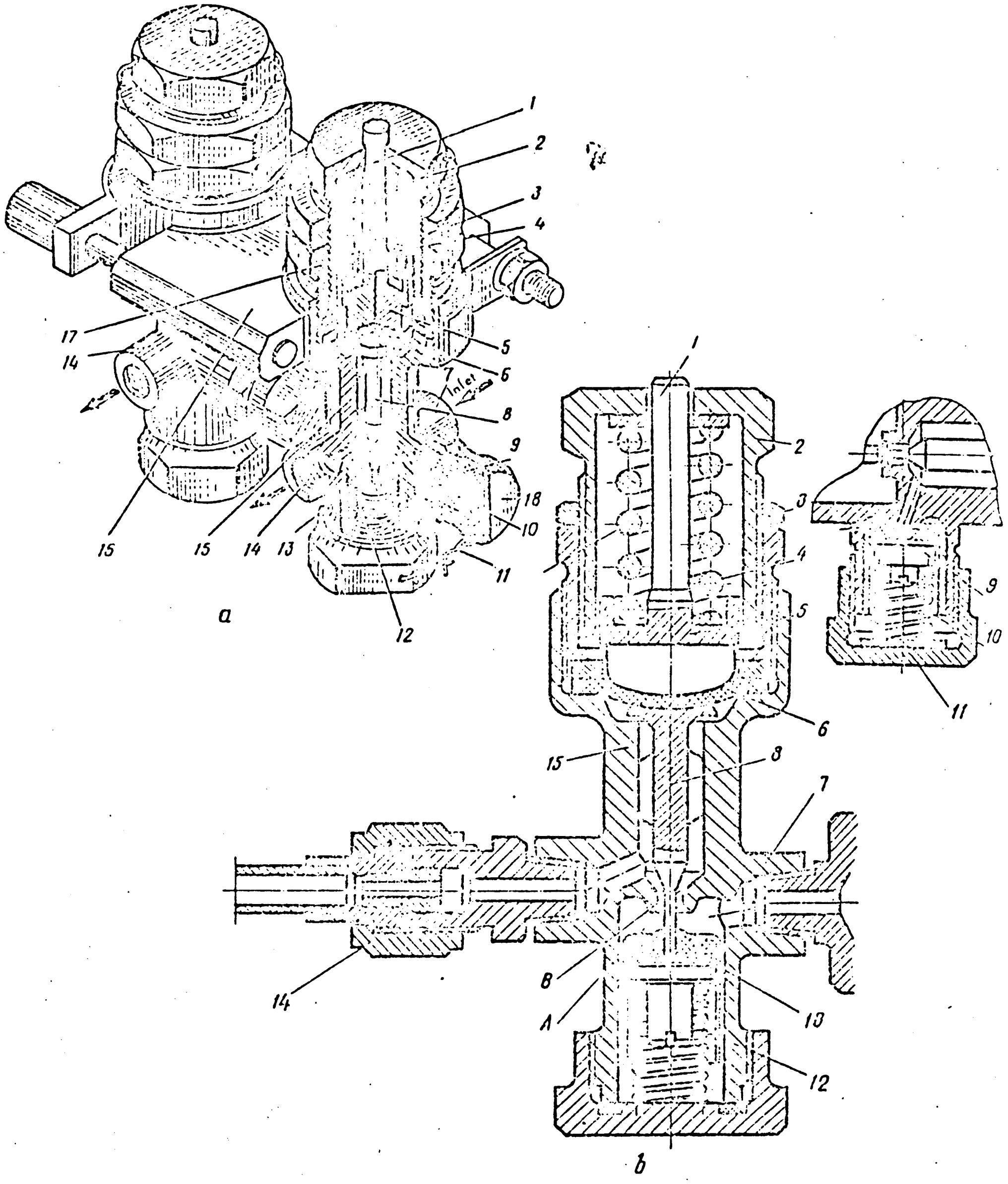
1
2
3
4
17
14
5
6
7
Inlet
8
9
18
10
15
15
14
13
11
12
a
1
2
3
4
5
6
15
8
7
14
B
A
13
12
9
10
11
b

FIG.318. AIR PRESSURE REDUCING VALVES 11.1-611-150/70

a - general view; b - sectional view of pressure reducing valve; 1 - piston rod; 2 - piston body; 3 - locknut; 4 - piston spring; 5 - piston; 6 - diaphragm; 7 - inlet pipe union; 8 - push rod; 9 - safety valve; 10 - valve spring; 11, 13 - union nuts; 12 - high-pressure valve spring; 13 - valve; 14 - outlet pipe union; 15 - reducing valve body; 16 - bracket; 17 - nut; A - space; B - nozzle

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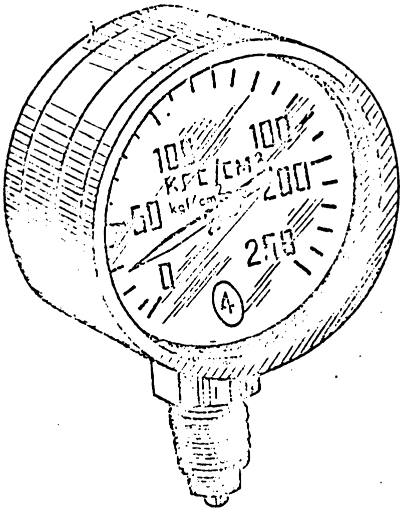
100
100
КГС/СМ2
50
kgf/cm2
200
0
250
4

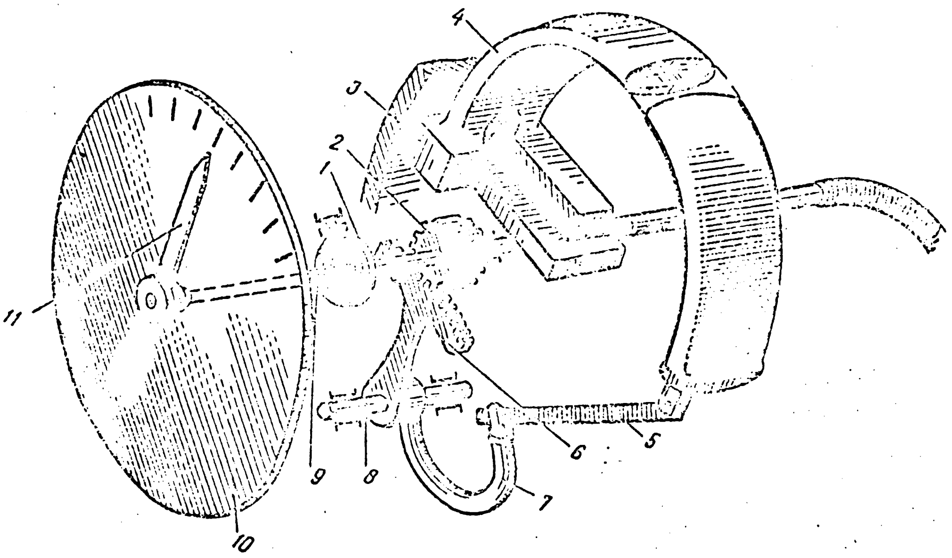
4
3
2
1
11
9
8
6
5
7
10

FIG.319. PRESSURE GAUGE OF PNEUMATIC SYSTEM

1 - spring (hair); 2 - pinion; 3 - base block; 4 - tubular spring; 5 - control rod; 6 - toothed sector; 7 - arc-shaped lever; 8 - sector axle; 9 - pointer axle; 10 - scale; 11 - pointer

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15.2.8. Pressure Gauge MT-1C

Pressure gauge 47 (Fig.308) serves to indicate the air pressure in the pneumatic system. The pressure gauge scale is graduated from 0 to 250 kgf/cm^2.

The pressure gauge is mounted on the pipeline connected to adapter box 9.

It represents a spring-type device in which resilient tubular spring 4 (Fig.319) serves as a sensing element. As compressed air is fed inside the spring, it straightens out, and turns axle 9 with pointer 11 through a transmission mechanism consisting of control rod 5, lever 7, toothed sector 6 and pinion 2. Spiral spring 1 secured on axle 9 serves to take up backlash.

15.2.9. Air Pressure Reducing Valve 669300/M14

Air pressure reducing valve (Fig.320) serves for further decrease of the air pressure (down to 14 kgf/cm^2) applied to the air intake pipe, air cleaner dust suction valve and engine clutch booster.

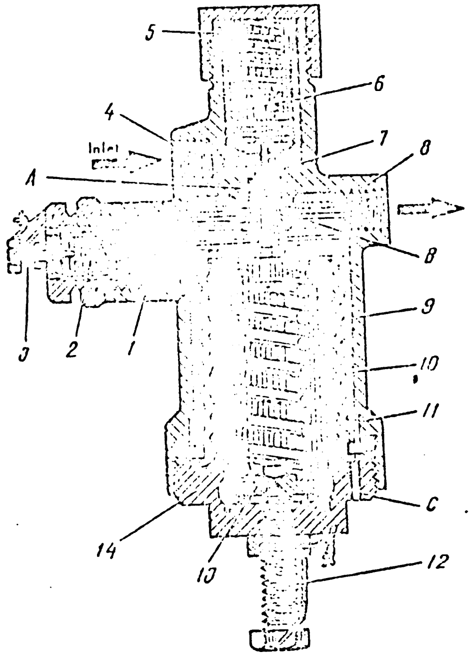

FIG.320. AIR PRESSURE REDUCING VALVE 669300/M14

1 - safety valve; 2 - valve spring; 3 - adjusting bolt; 4 - inlet pipe union; 5 - valve spring; 6 - valve; 7 - push rod; 8 - outlet pipe union; 9 - pressure reducing valve body; 10 - rubber corrugated cylinder; 11 - spring; 12 - adjusting bolt; 13 - spring stop; 14 - body cover; A - nozzle; B - space; C - drilled hole

The reducing valve is located on the left side of the driving compartment. It consists of housing 9, spring 11, valve 6, safety valve 1, corrugated cylinder 10, adjusting bolts 3 and 12, and two pipe unions 4 and 8.

Air enters the pressure reducing valve housing through pipe union 4 and then flows to space "B" over the corrugated cylinder through the gap between push rod 7 and nozzle "A". Und the action of the air pressure the corrugated cylinder is compressed, overcoming the resista of spring 11. Valve 6 moves down under the action of spring 5, thus reducing the cross-sectional area of the passage through which th air flows to chamber "B". As a result, the resistance to the air flow rises, and the pressure of outcoming air decreases. The effort of spring 11 and the cross-sectional area of noz "A" are so selected, that the pressure of the outcoming air is equal to 14 kgf/cm^2.

With the pressure rising and decreasing the pressure reducing valve functions in the same manner as pressure reducing valve HM-611.

The safety valve is similar to the safety valve of reducing valve HM-611 both in design and purpose.

15.2.10. Non-Return Valves

The non-return valves (Fig.321) serve to prevent penetration of oil from the air distr tor and valve box to the pneumatic system.

There are two non-return valves in the system. One valve is mounted on the pipeline the air distributor inlet, and the other, at the inlet of the valve box of the power tra mission hydraulic control system.

The non-return valve consists of cylindrical body 3 holding a screwed-on nut, valve and spring 5. The valve is hollow; it is pressed to the seat of the nut, thus disconnecti

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the pipe unions. As air is supplied through pipe [redacted] opens. When air containing oil particles moves back, the valve does not let it pass to the system.

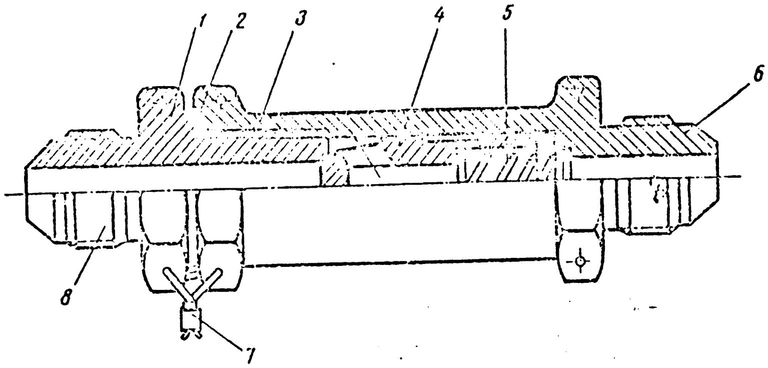

FIG.321. NON-RETURN VALVE OF PNEUMATIC SYSTEM

1 - inlet pipe union; 2 - gasket; 3 - valve body; 4 - valve; 5 - valve spring; 6 - outlet pipe union; 7 - locking wire; 8 - inlet pipe union

15.2.11. Pneumatic System Controls

There are the following pneumatic controls:

- interlocked control for the splash panel, air intake pipe and air cleaner dust suction valve;
- engine clutch release control;
- stopping brake control;
- engine air starting system control;
- vision device air-and-liquid cleaning system control;
- oil-and-moisture separator condensate discharge control.

The interlocked pneumatic control (Fig.322) combines the splash panel control, air intake
pipe control and air cleaner dust suction control. It consists of cocks 7 and 8 (Fig.322)
connected by means of a control rod, four pneumatic cylinders 10, 11, 12 and 13 and pipelines.
Lower cock 8 governs all the three mechanisms actuated by the interlocked pneumatic
control. As handle 1 is turned, the handle of upper cock 7 turns. To raise the splash panel
and the air intake pipe, and to close the dust suction valve, shift handle 1 from the LAND
(СУША) to the IN WATER (ВХОД В ВОДУ) position. Before placing handle 1 in the position IN
WATER, set it in the OUT OF WATER (ВЫХОД ИЗ ВОДЫ) position and then press the head of handle 1
so as to make retainer 15 enter slot "A" of the locking strap; after that shift the handle to
the IN WATER position seeing that retainer 15 enters slot "B" of the locking strap.
Upper cock 7 is designed to lower the splash panel, with the air intake pipe remaining
raised, and dust suction valve closed. Ear 3 of control rod 4 connecting both cocks has long
slot "C" which prevents rotation of handle 1 of cock 8 when handle 5 of cock 7 is turned.
To lower the splash panel, place handle 5 in the LOWERED (ОПУЩ.) position. In this position space "B" (Fig.24) communicates with the compressed air main, and space "A", with the
atmosphere, through cock 7 (Fig.322). After handle 5 is lowered, it returns to the RAISED
(ПОДН.) position under the action of spring 6, and the splash panel rises.

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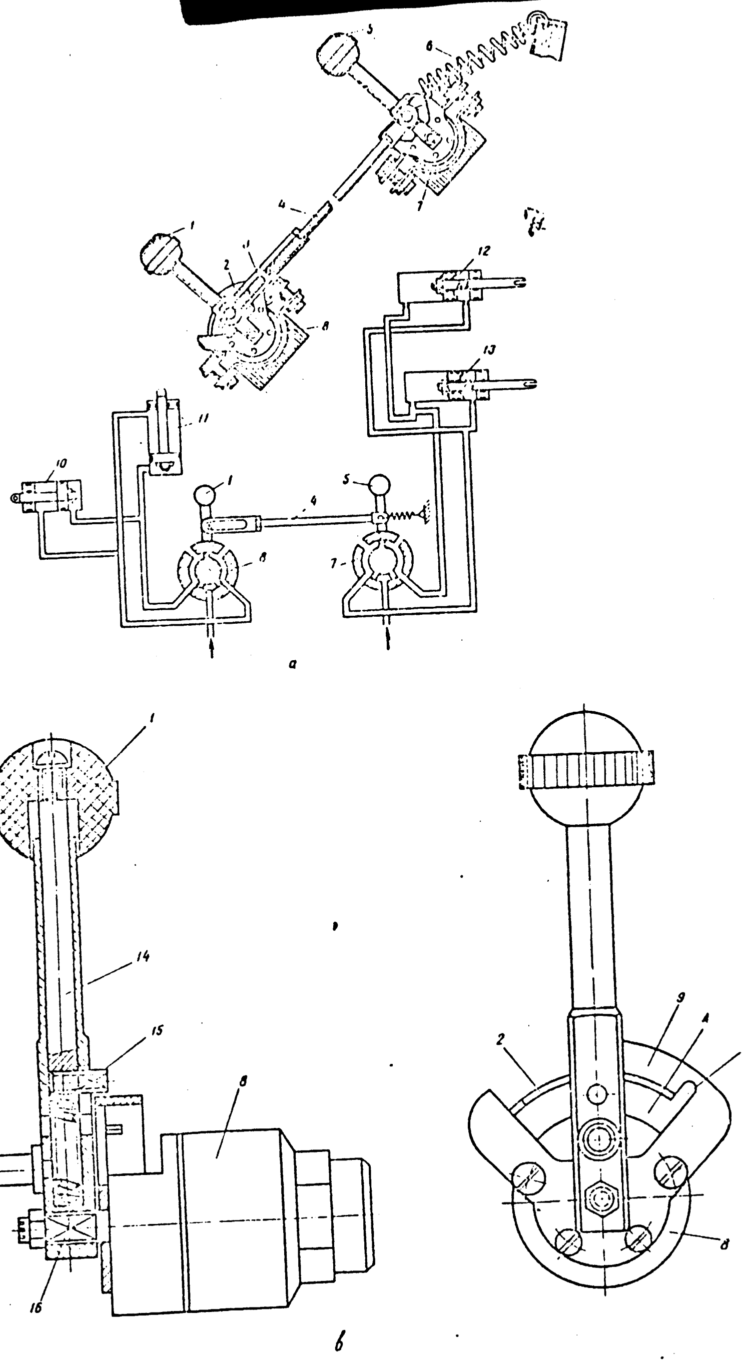

FIG.322. INTERLOCKED PNEUMATIC CONTROL

1 - handle of interlocked pneumatic control cock; 2 - spacer; 3 - control rod ear; 4 - control rod; 5 - handle of splash panel control cock; 6 - return spring; 7 - cock of interlocked pneumatic control; 8 - splash panel control cock; 9 - locking strap; 10 - pneumatic cylinder of air cleaner duct suction valve; 11 - pneumatic cylinder of air intake pipe; 12,13 - pneumatic cylinders of splash panel; 14 - handle retainer stem; 15 - retainer; 16 - cock axle; 17 - pin to connect control rod; A - slot in locking strap; B - slot in locking strap

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To lower the air intake pipe, open the dust suction valve and to lower the splash panel, shift handle 1 of lower cock 8 to the OUT OF WATER position, and after the splash panel lowers, disengage retainer 15 from slot "A" and move the handle to the LAND position.

As the handle passes by the neutral position (the handle axis coincides with the LAND position), the ducts in cocks 7 and 8 open and connect the working spaces of the pneumatic cylinders with the atmosphere. When the handle is in the OUT OF WATER position, the air is supplied through the cocks to the pneumatic cylinders of the air intake pipe, splash panel and dust suction valve.

The cock of the interlocked control (Fig.323) is of a revolving-valve type: it consists of body 6, union nut 9, valve axle 15 with revolving valve 11, handle 2 with the locking device, and pipe unions. The cock of the splash panel has no locking device.

Both cocks are arranged in the driving compartment to the left of the driver and attached with collars to the hull.

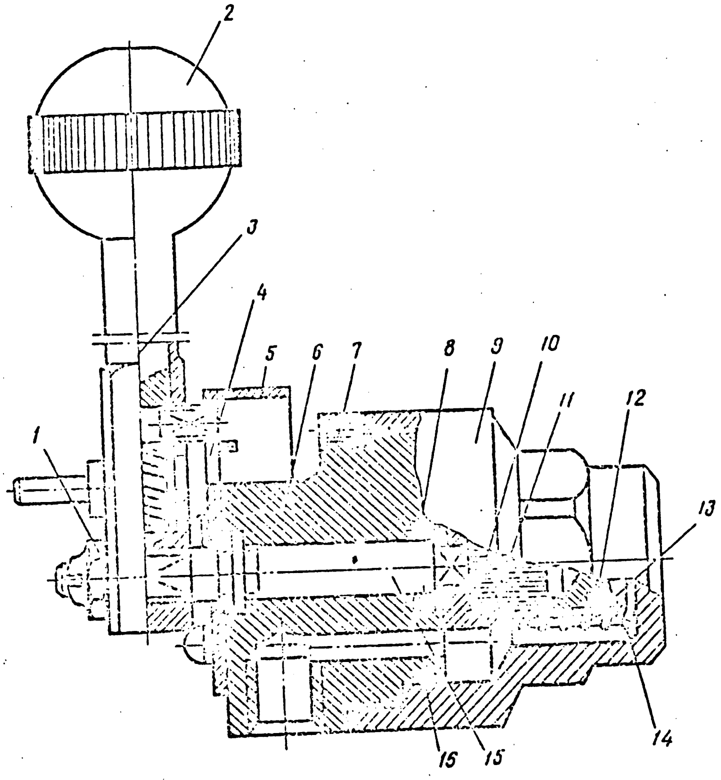

FIG.323. COCK OF INTERLOCKED PNEUMATIC CONTROL

1 - nut; 2 - handle; 3 - stem of handle retainer; 4 - locking strap; 5 - spacer; 6 - cock body; 7 - screw; 8 - packing; 9 - union nut; 10 - plug; 11 - revolving valve; 12 - sealing ring; 13 - sealing sleeve; 14 - spring; 15 - valve axle; 16 - sealing ring

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Cock handle 2 is fitted on axle 15 which carries valve 11 representing a cylinder having three blades. As the handle is turned, the valve is positioned so that the interblade space communicates the air inlet pipe union with the air outlet pipe union as shown in the cock operation diagram (Fig.322).

Two pneumatic cylinders of the interlocked pneumatic control control the splash panel, one cylinder controls the air intake pipe and one cylinder controls the air cleaner dust suction valve.

The air intake pipe and dust suction valve control cylinders differ in design from the splash panel control cylinders.

The splash panel control cylinder (Fig.324) consists of body 5, piston 7 with rod 6, packing sleeve 3 and pipe unions 4 and 8.

Piston rod 6 slides in packing sleeve 3 secured at the end of the body by means of a nut.

There are two packing rings outside the sleeve, and three packing rings inside the sleeve. The piston is packed with three rings. As compressed air is supplied through one of the pipe unions (to the space over or under the piston) the piston moves and raises (lowers the splash panel by its rod.

The pneumatic cylinders of the air intake pipe and dust suction valve (Fig.325) are similar in design.

The pneumatic cylinder consists of body 3, piston 6 with rod 4 and packing sleeve 2

Unlike the piston of the above-mentioned cylinder, piston 6 has only outer rings.

The operating principle of the pneumatic cylinder is similar to that of the above-mentioned cylinder.

The engine clutch release control consists of cock 45 (Fig.308), non-return valve 10 and pipelines.

The cock (Fig.326) includes body 1, ball valve 11, valve rod 7, handle 10, gland, gaske packing stuff 3 and union nut 4.

The valve rod is screwed into the body with its head provided at the rod lower end. Th head hole holds ball 11. The upper square end of the rod carries handle stem 9.

The packing stuff represents an asbestos cord impregnated with beef fat and graphite powder. Both ends of the body have ducts which may be disconnected by ball 11. As the handle is turned clockwise, the cock closes. The rod head enters the rod, and the ball closes the vertical duct.

The non-return valve prevents penetration of oil from the valve box to the pneumatic system.

For the valve design and operation see Subsection 15.2.9.

To release the engine clutch, depress the engine clutch pedal and turn cock handle 10 counterclockwise. As a result, compressed air flows from the cylinder through adapter box 9 (Fig.308), air pressure reducing valves (in which the air pressure is reduced to 70 kgf/cm^2), adapter box 46, air pressure reducing valve 42 (in which the pressure is reduc to 14 kgf/cm^2), cock 45, non-return valve 10 and enters valve box 11.

In valve box 11 of the power transmission hydraulic control system, the air flows via ducts (opened by the power transmission hydraulic control slide valve) to the engine clutc booster.

Depress the engine clutch pedal to make the slide valve close the ducts connecting the system with the drain line, since otherwise the air flows directly to the drain line, i.e. to the gear case and does not release the engine clutch.

The stopping brake control consists of electropneumatic valve 44 (Fig.308), pressure warning unit 52, limit switch 53 and pipelines; besides, the control system includes hollow rods 7 (Fig.213).

Electropneumatic valve ЭК-48 (Fig.327) is arranged in the driving compartment on the left side of the vehicle near the driver's seat.

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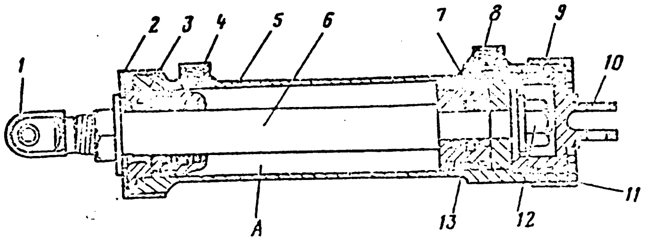

FIG.324. PNEUMATIC CYLINDER OF SPLASH PANEL

1 - piston rod ear; 2 - union nut; 3 - packing sleeve; 4 - pipe union; 5 - cylinder body; 6 - piston rod; 7 - piston; 8 - pipe union to supply air for raising the splash panel; 9 - sealing rings; 10 - cylinder ear; 11 - union nut; 12 - piston securing nut; 13 - piston sealing rings; A - space over piston

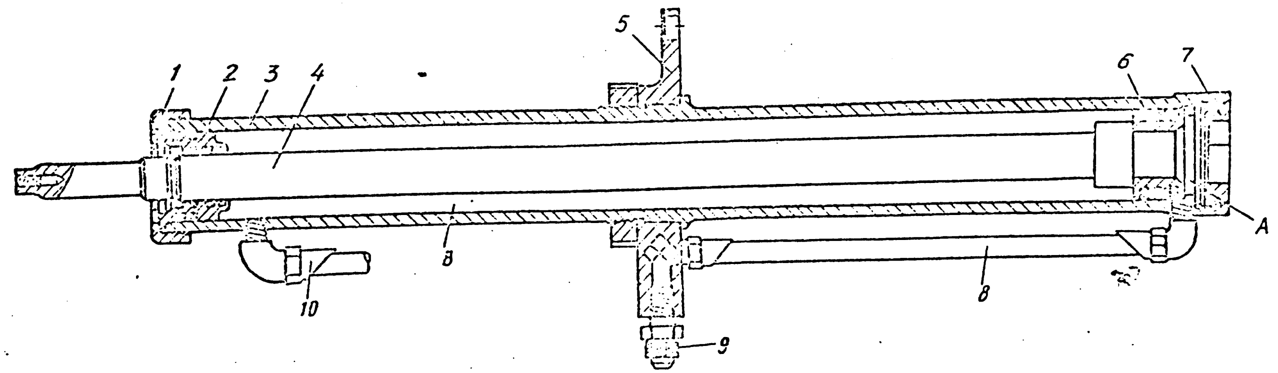

FIG.325. PNEUMATIC CYLINDER OF AIR INTAKE PIPE AND AIR CLEANER DUST SUCTION VALVE

1 - securing nut of packing sleeve; 2 - packing sleeve; 3 - pneumatic cylinder body; 4 - rod; 5 - flange; 6 - piston; 7 - plug; 8 - pipeline; 9, 10 - pipe unions; A - space under piston; B - space over piston

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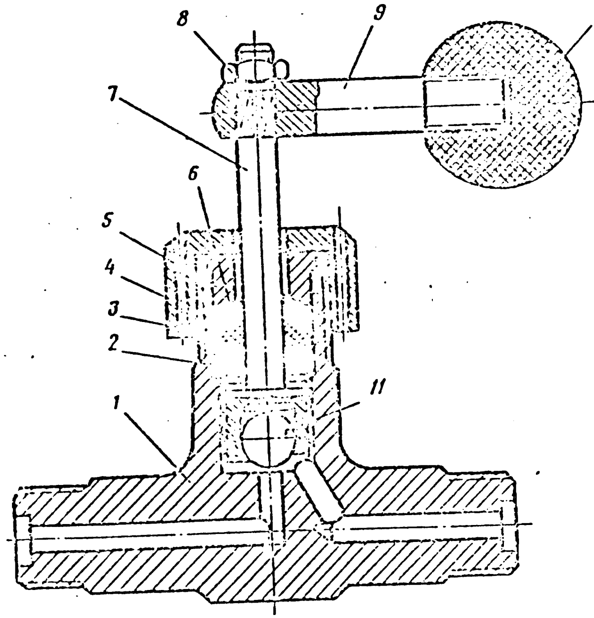

FIG.326. ENGINE CLUTCH RELEASE CONTROL COCK

1 - cock body; 2 - gasket; 3 - packing stuff; 4 - union nut; 5 - pressure bushing; 6 - gasket; 7 - valve rod; 8 - nut; 9 - handle stem; 10 - handle; 11 - ball valve

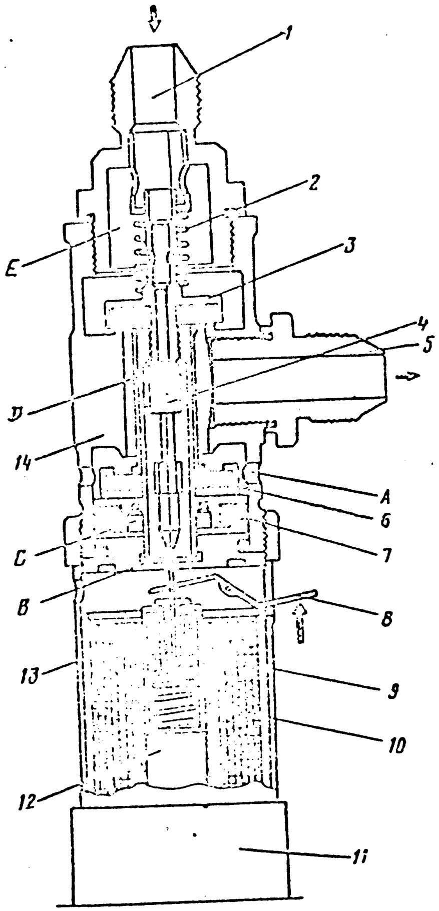

FIG.327. ELECTROPNEUMATIC VALVE

1 - inlet pipe union; 2 - inlet valve spring; 3 - inlet valve; 4 - servo-valve; 5 - outlet pipe union; 6 - outlet valve; 7 - piston; 8 - manual control lever; 9 - spring; 10 - electromagnet winding; 11 - casing; 12 - core; 13 - rod; 14 - valve body; A - hole communicating with atmosphere; B - duct; C - space under piston; D - inlet valve hole; E - space

[redacted]

[redacted]

It is designed for remote control of the compressed air supply to the stopping brakes.

The electromagnet of the electropneumatic valve is energized through the limit swit and pressure warning unit as the stopping brake pedal is pressed.

Electropneumatic valve 3K-48 consists of cylindrical body 14 with electromagnet casi 11, inlet valve 3 and outlet valve 6, piston 7, electromagnet of servo-valve 4, inlet pip union 1 and outlet pipe union 5, two springs and electropneumatic valve manual control lever 8.

Piston 7, inlet valve 3 and outlet valve 6 are interconnected; they move as a single unit.

The electropneumatic valve functions as follows.

In the initial position, when the stopping brake pedal is not depressed, compressed air kept in the pipelines fills up space "E", but cannot pass further since servo-valve 4 pressed by spring 9, tightly closes duct "D" of the inlet valve. As the stopping brake pedal is depressed, and the pressure warning unit operates (when the pressure in the power transmission hydraulic control system is less than 2.6 kgf/cm^2), the mains current is supplied to the electromagnet winding, and core 12 displaces under the action of the magne field; the core pulls servo-valve 4 through rod 13, thus opening duct "D" and closing duct "B". Compressed air flows from space "E" through duct "D" to space "C" under the piston a displaces piston 7 and inlet valve 3 and outlet valve 6.

Inlet valve 3 fully opens the air duct leading to pipe union 5, and outlet valve 6 stops communication with the atmosphere.

Compressed air flows from the pneumatic system through inlet pipe union 1 and outlet pipe union 5 and pipelines to the hollow rods of the stopping brake boosters and tightens the bands.

If the electric circuit of the electromagnet is faulty, the electropneumatic valve may be switched on by means of lever 8 fitted on an axle. As lever 8 is pressed towards the pipe unions, the fork fitted on its end presses the collar of rod 13 and shifts the latter together with core 12 of the electromagnet and inlet and outlet valves, thus admitting the compressed air as well as during operation of the electromagnet.

Pressure warning unit 14 (Fig.213) represents a hydroelectric relay closing the circui of the electropneumatic valve electromagnet when the oil pressure in the hydraulic control system of the power transmission drops down to zero or decreases below 2.6 kgf/cm^2. As to its design, the pressure warning unit is similar to the sending unit of the pressure gauge, consisting of a cylindrical body, one movable and two stationary contacts, spring, diaphrag assembly, inlet pipe union and electric wires.

In the initial position, the movable contact is pressed by a spring to the stationary contacts. The movable contact is joined with the diaphragm assembly through the inlet pipe union which is connected to a flexible oil line running from the main of the power transmission hydraulic control system.

With the engine running, when the pressure in the hydraulic control system reaches 2.6 kgf/cm^2, the diaphragm deflects, and the movable contact moves away from the stationary contacts, opening the circuit of the electropneumatic valve. With the engine being inoperative, or when the pressure is less than 2.6 kgf/cm^2, the contacts of the pressure warning unit are closed.

To actuate the pneumatic control, press stopping brake pedal 7 (Fig.205). As a result, lever 47 presses the button of limit switch 31 which closes the circuit of electropneumatic valve 20 (Fig.213) and, if the pressure in the hydraulic control system is less than 2.6 kgf/cm^2 the current flows via limit switch 1 and permanently closed contacts of pressure warning unit 14 and then over the winding of the electromagnet of electropneumatic valve 20.

The magnetic field produced by the electromagnet causes core 12 (Fig.327) to move and electropneumatic valve 20 (Fig.213) to operate.

[redacted]

As a result, the compressed air flows from cylinder 35 (Fig.308) through adapter box 9, air filter 8, air pressure reducing valve 7, adapter box 46, electropneumatic valve 44, sleeve 1, pipelines to pipe unions 7 (Fig.206) of the hydraulic cylinders and then enters rods 5. The latter move together with hydraulic cylinder pistons 4 under the action of compressed air and tighten up the brake bands.

The air starting system control consists of electropneumatic valve 37 (ЭК-48) (Fig.308), system of pipelines and electropneumatic valve start button AIR DELIVERY (ПУСК.ВОЗД.) located on the central panel.

Electropneumatic valve 10 (Fig.6) is arranged in the driving compartment on the left side of the hull.

It is identical in design to electropneumatic valve ЭК-48 described above.

As the electropneumatic valve operates, air passes from cylinder 35 (Fig.308) through adapter box 9, air filter 8, air pressure reducing valves 7 and adapter box 46 to electropneumatic valve 37 and thence through oil settler 16 to air distributor 17 of the engine. From the air distributor the air passes to the cylinders where it actuates the pistons and thus cranks the engine. After button AIR DELIVERY has been released, the circuit of winding 10 (Fig.327) of the electropneumatic valve electromagnet opens, and core 12 moves together with the servo-valve under the action of spring 9, and the servo-valve closes hole "D", thus cutting off the compressed air supply to space "C", and opens duct "B", thus connecting space "C" with the atmosphere. Inlet valve 3 disconnects inlet pipe union 1 and outlet pipe union 5, under the action of spring 2, and outlet valve 6 moves away from the seat, thus connecting outlet pipe union 5 with the atmosphere.

The vision device air-and-liquid cleaning control consists of electropneumatic valve 36 (Fig.308), cock 30, pipelines, button CLEANING (ОЧИСТКА) (on the central panel) and the button provided on the vision device cleaning control panel.

The electropneumatic valve (ЭК-48) is attached to the left side of the hull over valve ЭК-48 of the engine air starting system. The valve is identical in design to the valve described above.

The cock is of a plug two-position type; it serves to change over the cleaning system from the driver's devices to the commander's device. It is arranged in the driving compartment to the left of the commander.

Button CLEANING on the vision device cleaning control panel arranged to the left of the commander serves to control the electropneumatic valve from the commander's seat, and button CLEANING on the central panel serves to control the electropneumatic valve from the driver's seat. As one of these buttons is pressed, the electropneumatic valve operates and the air passes from the system over the pipelines and through adapter box 9, air filter 8, pressure reducing valves 7, adapter box 46, electropneumatic valve 36 to ejector 31; thence it passes to cock 30.

Depending on the position of the handle of cock 30, the spray of water emulsion is supplied either to driver's vision device 20 or to commander's vision device 29.

The oil-and-moisture separator condensate discharge control consists of cock 43, nozzle 15 and pipelines.

Cock 43 is arranged on the vehicle floor to the right of the driver's seat.

As to its design and operating principle, this cock is similar to the cock of the engine clutch release control system described above.

To discharge the condensate, turn cock handle 7 (Fig.316). As a result, the compressed air kept in the oil-and-moisture separator passes through bottom pipe union 8 of the latter and catches condensate. It flows over pipeline 20 and through cock 6 and pipeline connecting the cock with nozzle 15 (Fig.308), and discharges the condensate outwards via nozzle 15.

Discharge the condensate, with the engine running.

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15.3. CARE OF PNEUMATIC SYSTEM

15.3.1. General

The care of the pneumatic equipment includes:

- periodic washing of air filters of pressure control unit АДУ-2С and compressor;
- checking and adjusting the tension of compressor drive belts;
- regular removal of condensate from the oil-and-moisture separator;
- replacement (if necessary) of the diaphragm in air pressure reducing valve НЛ-611;
- regular checks of the pipeline and electropneumatic valve connections for air leakage;
- draining of condensate from the oil settler provided in the pipeline of the engine air starting system;
- lubrication of the compressor drive pulley;
- lubrication of the bearings of the tightening roller of the compressor drive;
- checking of the pneumatic control systems for reliable functioning;
- draining of water from the tanks of the vision device air-and-liquid cleaning system, when preparing the vehicle for winter operation.

15.3.2. Washing of Air Filter of Pressure Control Unit АДУ-2С and Filter of Pressure Reducing Valves

Wash the filters every 8000 km of run.

Do it as follows:

(a) Unscrew the securing bolts of the front ribbed plate of the hull, raise the plate and lock it.

(b) Unscrew union nuts 48 (Fig.308) of the air filters, having first unlocked them.

(c) Unscrew the securing nuts of filter collars 49.

(d) Remove collars 49 and filters 8.

(e) Unscrew union nuts 13 (Fig.316) of the filters, remove springs 11 and filter elements.

(f) Wash felt plates 15, screens 16 and 17, casings, union nuts 13 and springs 11 in gasoline.

(g) Place the filter elements in the casings using the following sequence: coarse-mesh screen, felt plate, fine-mesh screen, felt plate, fine-mesh screen, etc. and the spring.

(h) Screw the union nut on the filter casing as far as it will go.

(i) Screw the union nuts on the filter pipe unions.

(j) Reinstall the clamps and secure the filters with nuts.

(k) Lock the union nuts.

15.3.3. Checking and Adjusting Compressor Drive Belt Tension

Check and adjust the compressor drive belt tension daily.

Do it as follows:

(a) Turn the turret by 120° to the right, remove cover 21 (Fig.15);

(b) Apply an effort of about 4 kgf to the middle of the belt (from above) by hand between pulleys 6 and 21 (Fig.309). If the belt deflection is less than 15 mm, decrease the belt tension, for which purpose rotate turnbuckle 19 counterclockwise. If the deflection exceeds 22 mm, increase the belt tension, for which purpose rotate turnbuckle 19 clockwise. Normal deflection is in the range from 15 to 22 mm.

(c) Put on the hatch cover.

15.3.4. Washing Compressor Air Filter

Wash the compressor air filter every 4800-5000 km of run.

Do it as follows:

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(a) Uncotter and unscrew the union nuts of the pipe unions of air filter 26 (Fig.309) of the compressor (on the engine compartment bulkhead behind the commander).

(b) Unscrew the bolt of the filter collar and remove the filter.

(c) Uncotter and unscrew the securing nut of filter cover 6 (Fig.317) and take out the filter element.

(d) Remove the thread, detach the filter bag and clean it.

(e) Assemble the filter in the reverse order.

(f) Screw the union nuts on the pipe unions and cotter them.

(g) Attach the filter casing to the engine compartment bulkhead by means of the collar.

15.3.5. Replacement of Diaphragm in Pressure Reducing Valve HA-611

Replace the diaphragm, when required.

Do it as follows:

(a) Unscrew the securing bolts of the front ribbed plate of the hull, raise the plate and lock it.

(b) Unscrew nuts 50 (Fig.303) and disconnect the air pipes from the air pressure reducing valve.

(c) Remove air pressure reducing valve 7.

(d) Clean the air pressure reducing valve of dust and dirt.

(e) Unscrew nuts 17 (Fig.318) and remove the head with push rod 8.

(f) Replace diaphragm 6 of the pressure reducing valve with a new one.

(g) Install the head with push rod 8 and screw on nut 17.

(h) Install the air pressure reducing valve on its place.

(i) Connect the air pipes to the pressure reducing valve and screw on nuts 50 (Fig.303) with a wrench.

(j) Put the front ribbed plate on its place.

15.3.6. Renewal of Grease in Bearings of Drive Pulley 6 (Fig.309) and Tension Pulley 17 of Compressor Drive

Renew the grease every 8000 km of run or at least once every four years. Time it with the scheduled preventive maintenance.

Renew the grease as follows:

(a) Traverse the turret by 120° to the right and remove cover 21 (Fig.15) from the access hole in the engine compartment bulkhead.

(b) Uncotter and unscrew plugs 3 and 15 (Fig.310) of the filler and level holes.

(c) Using a grease gun, pack grease ЦИАТИМ-201 till the latter is forced out of the level holes.

(d) Reinstall the plugs and cotter them.

(e) Close the access hole of the engine compartment bulkhead.

15.4. TROUBLES AND REMEDIES

Trouble	Cause	Remedy
With buttons AIR DELIVERY, CLEANING, or with stopping brake pedal depressed, system fails to operate	Circuit of corresponding electropneumatic valve ЭК-48 broken	Check circuit and eliminate trouble
Low pressure in pneumatic system	Diaphragm of air pressure reducing valve HA-611 damaged	Replace diaphragm

Trouble	Cause	Remedy
	Compressor drive belt loose	Adjust belt tension
	Condensate discharge cock opened	Close cock
	Air pressure control unit АДУ-2С is faulty because of ingress of dirt	Remove unit АДУ-2С and wash it with pure diesel fuel; for this purpose, fill in fuel through inlet and outlet pipe unions and through valve holes and then blow them off with compressed air
	Air leakage through connections of pipelines or joints of pneumatic equipment	Inspect connections and eliminate troubles

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16. OPERATION OF VEHICLE

16.1. SAFETY RULES

16.1.1. Vehicle

Before starting the vehicle, make sure that the rear doors are reliably closed, signal lamp DOOR (ДВЕРЬ) is dark on the central panel.

The open hatch doors must be securely locked.

When red signal lamps CLOSE HATCHES (ЗАКРОЙ ЛЮКИ) light up near the driver and in the troop compartment, immediately close all the hatches.

Before leaving the vehicle in a combat situation, the troopers must close the firing ports and the hatches.

It is allowed to leave the vehicle through the rear doors during movement in the first gear over level ground. In this case the open rear doors must be locked. After the troopers have left the vehicle the doors must be closed.

16.1.2. Armament

Traverse the turret, depress the gun, fire the gun and machine gun, and launch the anti-tank guided missile only with the hatches closed.

Traverse the turret, elevate the gun, close L.M. (МЗ), DRIVE (ПРИВОД) switches, press buttons LEVERS LOWERING (ОПУСКАНИЕ РЫЧАГОВ) and CONVEYER (КОНВЕЙЕР), only upon occupying the operator's seat, with the seat guard installed.

While manually laying the gun in the forward left-hand sector, take care not to damage the ОУ-3ГА2 spotlight, when the latter is mounted.

With switches L.M. and DRIVE closed, it is prohibited:

(a) to stay and to do any work in the zone of action of the levers;

(b) to lock and unlock the gun manually, and to ram the round from the through manually.

While manually loading the gun, be sure to return the breechblock opening lever to the initial position upon opening the breechblock.

Never press the ejectors by hand when the bore is open.

It is prohibited to manually ram the round to the ejectors without the use of the ramrods since the closing breechblock may injure the hand.

While loading the machine gun, push the retracting handle to the forward position after the moving parts have been engaged by the sear.

Do not touch the gun or machine gun by any part of the body at the instant of firing.

In case of misfire, wait for at least one minute and then proceed to find out and eliminate the cause of trouble.

Prior to installation of the troopers' machine guns and submachine guns in the ball supports of the firing ports, set them at safe. It is forbidden to release the machine guns from safety before the firing ports are opened.

Be careful not to strike the round head or electric primer.

On removal of the ammunition allowance from the vehicle, put the safety caps on the fuze heads.

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It is forbidden to use the 9M14M missiles which have been dropped from any height, when unpacked, or from a height above 0.5 m, when packed. Such missiles must be checked by specialists for serviceability.

It is forbidden to remove the 9M14M missiles from the packing by the fins or to place them on the guide rails, holding them by the fins. While installing the missiles, see that they do not rest on their fins.

If the missile fails to slip from the guide rails even after button START has been pressed for the second time, shift switch GUIDE RAILS (НАПРАВЛЕНИЕ) to position "0", and five minutes later remove the guide rail with the missile and put it in the stowage place.

Never remove the round or dummy from the barrel bore, with switches L.H. closed.

16.1.3. General

Fill the vehicle with fuel, oil and coolant, with the engine stopped.

Never suck in fuel or oil by mouth.

Drain the fuel into a vessel.

Never illuminate the interior of the vehicle with open flame.

Prior to installation of the storage batteries, do the following:

(a) open the battery switch;

(b) prevent any contact between the battery terminals and the body.

Replace the blown fuses by standard fuses only. Do it, with the battery switch opened. Replace the fuses in the supply unit of the radio station, with the latter switched off.

The cylinders of the fire-fighting equipment and the compressed-air cylinders must be inspected at least once every five years. The cylinders and valves should be repaired in special workshops.

Before checking the fire-fighting equipment for serviceability by means of a heater, make sure that no fuel nor oil are spilt on the vehicle floor.

In case of fire the crew should start the fire-fighting system and leave the vehicle. After the fire has been extinguished, switch on the blowers and run the engine for 3-5 min in order to ventilate the vehicle.

16.2. VEHICLE DRIVING

16.2.1. General

Strict observance of the main rules of vehicle operation and maintenance ensures reliable and trouble-free operation of the vehicle.

When on the move, the driver should regularly watch the instruments and select the appropriate travelling duty.

He should drive the vehicle at a speed ensuring the fulfilment of the assigned mission, but at the same time he should avoid overloading of the power plant and power transmission and sharp blows of the road wheel arms against the stops.

The travelling duty and the direction of movement must be such that gear shifting, sharp turns and stops can be avoided on upgrades, downgrades, hillsides, swampy terrain and loose ground.

When on the move, never keep the foot on the engine clutch pedal.

When travelling in dust-laden and unfavourable atmospheric conditions, it is recommended to use the driver's hood.

To change over from the forward to reverse run, stop the vehicle.

While moving at high speeds, especially on slippery ground, do not make sharp turns in order to avoid skidding. The driver should bear in mind that vehicle steering does not demand great efforts.

If diesel fuel is not available, it is permissible to use jet engine fuel T-1 or TC-1. However, the average speeds of movement and the fuel distance of the vehicle are reduced, and the time required to warm-up the engine by the preheater is increased approximately by 20%.

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If the engine suddenly stops at the coolant temperature above +85%, it is difficult to start the engine immediately after the stop.

It is recommended to wait until the preheater pump (which starts automatically) decreases the coolant temperature down to +70°.

When the engine operates on fuels T-1 and TC-1, usage of the smoke-generating equipment is not allowed.

16.2.2. Preparation for Movement

While preparing the vehicle for motion, carry out the routine inspection. Make sure that the fuel, lubricating and cooling systems are filled to capacity, the storage batteries are charged, and the cylinder is filled with air; also see that the hatch doors and the access hole covers, and plugs are available and reliably secured, the vision devices are clean, and the seats are properly adjusted.

Eliminate all the troubles detected.

Preparing the engine for start in conditions of high temperatures (at a temperature above +5°C) should be done as follows.

(a) Make sure that the switches on the central panel are in the OFF position.

(b) Set lever 13 (Fig.201) at neutral, and low range control lever 15 at the upper position.

(c) See that manual fuel feed control handle 43 (Fig.6) is at a zero feed position; the handle must be turned all the way clockwise.

(d) Open the ejector louvres and shutters, for which purpose turn handle 34 upward.

(e) Close battery switch 24 (Fig. 246) BATTERY SWITCH (ВЫКЛ.БАТАР.);

(f) Turn on the central panel illumination by switch 11 PANEL ILLUMINATION (ОСВ.ЩИТКА);

(g) Open the engine protection valves by turning handle 32 (Fig.6) to the lower position.

(h) Shift handle 50 of the fuel system cock to position "O" (open);

(i) Open valve 3 of the compressed air cylinder.

(j) Prime the fuel system with fuel by means of pump БЦН, for which purpose close switch 4 "БЦН" (Fig.246).

Preparing the engine for start in low temperature conditions (at a temperature below +5°C) should be done as follows:

(a) Proceed as outlined in Items a,b,c of the previous Subsection.

(b) Close battery switch 24 (Fig.246).

(c) Close the louvres, for which purpose turn handle 34 (Fig. 6) all the way down, with latch 11 (Fig. 180) of handle 10 in the horizontal position and cover them with mats (the ejector shutters must be open).

(d) Open the engine protection valves for which purpose turn handle 32 (Fig.6) to the lower position.

(e) Set fuel cock handle 50 in position "O" (open) and open preheater cock 47;

(f) Switch on the preheater; do it as follows:

- open cover 17 (Fig.20) of the preheater exhaust hole; to do it, unscrew nut 2 and turn handle 8 clockwise till it is locked.
- close switch 4 "БЦН" (Fig.246) for 10-15 s and prime the fuel system;
- if the ambient air temperature is below -20°C, close the preheater choke, for which purpose set handle 51 (Fig.6) in position "3" (closed);
- close switch 20 PLUG (СВЕЧА) (Fig.246);
- 1-1.5 min after the glow plug is switched on, fully open preheater fuel supply cock 47 (Fig.6), and 20-30 s later, close switch 21 ENGINE HEATING (ОБОГРЕВ ДВИГ.) (Fig.246); if the

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fuel is not ignited in the preheater boiler, open switch ENGINE HEATING, and close it again 20-30 s later;

- after the fuel has ignited and starts burning steadily, open switch 20 PLUG (СВЕЧА) and open the preheater choke, for which purpose shift handle 51 (Fig.6) to position "O" (open);

CAUTION: 1. Do not keep switch PLUG closed for longer than three minutes running.

2. After several attempts to ignite the fuel have proved unsuccessful, close preheater fuel cock 14 (Fig. 15), open switches ENGINE HEATING and PLUG, and then repeat the fuel igniting procedure in the sequence described above.

(g) Proceed with engine warm-up until the coolant temperature reaches +60°C (watch the left-hand scale of temperature gauge 30 (Fig.246).

(h) Press button 34 PUMP (НАСОС) and build up an oil pressure in the engine lubricating system of at least 3 kgf/cm^2 (while doing so, watch oil pressure gauge 28), and then release the button, do not keep the button pressed for longer than 1 min. If the required pressure would not be built up for this period, proceed with heating of the coolant to 90-100°C, periodically closing the switch of the oil priming pump.

(i) After an oil pressure of 3 kgf/cm^2 is built up, stop the preheater if the temperature of the fluid of the power transmission hydraulic control system provides for reliable operation of the latter (this is considered true if pressure gauge 27 (Fig.246) does not indicate any pressure drop when the engine clutch pedal or stopping brake pedal is depressed); do it as follows:

- close cock 14 (Fig.15) by turning ring 8 (Fig.191) all the way counterclockwise and 15-20 s after the fuel has stopped burning in the preheater boiler, open switch ENGINE HEATING on the central panel;

- close the preheater hole, for which purpose turn handle 8 (Fig.20) all the way counterclockwise and tighten up nut 2.

CAUTION: To accelerate vehicle preparation for motion, it is good practice to keep the preheater running until the engine and the hydraulic control system are ready for operation.

Starting the engine by compressed air is done as follows:

- give a sound signal;

- start the oil priming pump by pressing button PUMP under cover 34 (Fig.246) and build up a pressure of at least 3 kgf/cm^2 in the engine lubricating system; at an oil temperature of +60°C and above, the oil pressure must not be less than 2 kgf/cm^2;

- keeping button PUMP pressed, depress the fuel feed pedal to half its full travel and press button 18 AIR DELIVERY (ПУСК ВОЗД.) till engine starting; after the engine has started, release buttons AIR DELIVERY and PUMP, establish the crankshaft speed within 800-1000 rpm by manual control handle 43 (Fig.6);

CAUTION: Do not keep button PUMP pressed for longer than 1 min running.

- if the circuit of button AIR DELIVERY is not serviceable, start the engine by pressing lever 8 (Fig.327) of the electropneumatic valve;

- if the air starting system is faulty, start the engine by the starter.

Starting the engine by the starter is performed as follows.

Proceed in the same way as when starting the engine by compressed air, but press button STARTER (СТАРТЕР) instead of button AIR DELIVERY;

CAUTION. Do not keep the STARTER button pressed for longer than 5 s running. Try to switch on the starter again not earlier than 15 s after the previous start.

- if three attempts to start the engine prove unsuccessful, find out and eliminate the trouble. After that, start the engine.

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Starting the engine by the combined method is performed in case the pressure in th compressed-air cylinder is not sufficient, and the storage batteries are not sufficientl charged. To start the engine by the combined method, means to switch on the starter and supply compressed air simultaneously. For this purpose do the following;

- give a warning signal;
- start the oil priming pump and build up the necessary pressure (2-3 kgf/cm^2);
- keeping the oil priming pump running, depress the fuel feed pedal to half its ful travel and simultaneously push buttons AIR DELIVERY and STARTER on the central panel;
- immediately after the engine has started, release both buttons, and adjust the en gine speed within 800-1000 rpm by the manual control handle.

Starting the engine by use of external power source is performed as follows:

- open the battery switches on the vehicle and on the external power supply source
- insert the ends of the cables in the jacks of the vehicle slave starting socket a external power source socket, observing the polarity;
- close the battery switch on the external power supply source;
- start the engine as outlined in Subsection "Starting the Engine by Starter";
- after the engine has started, open the battery switch on the external power suppl source and disconnect the cables first from the vehicle and then from the external power supply source;
- close the battery switch on the vehicle.

Starting the engine by towing the vehicle is allowed in exceptional cases only when all the other methods cannot be used.

Do it as follows:

- interconnect the vehicles by wire ropes;
- start the oil priming pump by pressing button PUMP and build up a pressure of at least 3 kgf/cm^2 in the lubricating system; at an oil temperature of +60°C and above, the pressure should not be less than 2 kgf/cm^2). Release the button;
- depress the engine clutch pedal and open cock 45 (Fig.308) of the engine clutch pneumatic control;
- shift in the third or fourth gear, and the first or second gear on the towing vehicle respectively, i.e. two gears lower than on the vehicle to be towed;
- close cock 45 and release the engine clutch pedal;
- give a sound signal;
- start motion;
- switch on the oil priming pump and depress the engine clutch pedal by half its ful travel.

As soon as the engine starts running, switch off the oil priming pump;

- depress the engine clutch pedal all the way down, shift the gearshift lever to neutral, and then release the engine clutch pedal;
- adjust the engine speed within 800-1000 rpm by the manual fuel feed control handle;
- stop towing, disconnect the wire ropes and stow them in place.

Warm-up of engine and hydraulic drive system is performed as follows.

After the engine starting the oil pressure in the lubricating system should not be less than 2 kgf/cm^2. At the initial several minutes of engine running the oil pressure in the lubricating system may be considerably higher (especially in winter). If the oil pressure is not sufficient, stop the engine and find out the cause of trouble.

Begin the engine warm-up in summer and winter at the engine speed within 800-1000 rp and gradually change over to 1500-1800 rpm.

It is not allowed to warm up the engine at a high speed and a minimum steady speed.

To accelerate the warm-up, start motion in low gears at a speed of not above 1600 rp after the oil and water temperatures reach +30°C.

The engine is considered warmed up and ready for operation at all speeds when the te perature of the coolant and oil is equal to +55°C.

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While warming up the engine, it is recommended to close the louvres, for which purpo shift ejector louvres and shutters control handle 10 (Fig.180) all the way down, with latch 11 in the horizontal position. In winter time cover the louvres with mats.

CAUTION. With the engine running, the ejector shutters must be kept open. To avoid ac cidental closure of the shutters, set latch 11 in the horizontal position after handle 10 has been shifted to the upper position.

During the engine warm-up make sure that the battery charging current indicated by th voltammeter is not less than 5 A.

In winter time, before placing the vehicle in motion, prepare the power transmission control system for operation, with the engine running. Do it as follows: depress the engin clutch pedal and the stopping brake pedal in succession several times, each time making a pause for 20-30 s.

If depressing the engine clutch pedal or the stopping brake pedal does not cause pres sure drop in the gearbox lubricating system (watch the pressure gauge), the system is considered ready for operation.

Recommended instrument readings at service duty are the following.

Crankshaft speed:

(a) minimum idle speed 700-800 rpm, continuous operation at an idle speed of 700 rpm is not recommended. Do not run the engine at an idle speed for a long time at the oil and coolant temperature below +65°C so as to avoid gumming of valves, pistons and injector atomizers.

(b) operating range .... 1500-2600 rpm;
(c) recommended speed .... 1800-2400 rpm;
(d) maximum speed .... 2800 rpm.

Coolant temperature:

(a) recommended .... +80 to +100°C;
(b) maximum permissible during continuous operation .... +120°C
(c) permissible within 10 min. .... +125°C
(d) minimum .... +55°C

Note. The temperature of low-freezing liquid in the cooling system should not exceed +105°C.

Oil temperature:

(a) recommended .... +80 to +100°C
(b) maximum permissible during continuous operation .... +120°C
(c) permissible within 10 min .... +125°C
(d) minimum .... +55°C

Oil pressure in engine lubricating system (at oil temperature within +80 to +100°C):
(a) at 2200 rpm .... 6 to 10.5 kgf/cm^2
(b) at minimum speed .... 2 kgf/cm^2, min

At the oil temperature below 55°C the oil pressure may be up to 13 kgf/cm^2.

Oil pressure in gearbox lubricating system:

(a) at 1500-2600 rpm .... 1.5 to 3.5 kgf/cm^2
(b) at 800-1000 rpm .... 1 kgf/cm^2, min

CAUTION. If the oil pressure drops abruptly, or if the oil or coolant temperature rises suddenly, shut down the engine and find out the cause of the trouble.

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16.2.3. Rules of Vehicle Driving

Before motion make sure that the gun signal lamps GUN POSITION (ВЫХОД ЗА ГАБАРИТ) are dark; if they glow, traverse the turret so as to direct the gun forward along the vehicl

(if the movement, with the turret facing sideways, is not expected).

See that the doors are closed. Lamp DOOR (ДВЕРЬ) on the driver's panel should be dark.

Make sure that the manual fuel feed control handle is in a position corresponding to crankshaft idle speed of 800-1000 rpm.

When placing the vehicle in motion on level road it is recommended to do the following:

(a) Turn parking brake handle 39 (Fig.6) to the left (if the brake is applied) and push it all the way forward and then turn the handle to the right and down; see that signal light panel RELEASE HAND BRAKE (ОТПУСТИ РУЧНОЙ ТОРМОЗ) goes out.

(b) Depress the engine clutch pedal.

(c) Shift in the necessary gear. The choice of the gear depends on the nature and state of the soil. On dry hard ground start motion in the second gear. Under extremely heavy condi tions (deep mud or snow, swamp, etc.) place the vehicle in motion in the second low range gear or the first gear.

(d) Give a sound signal to warn that the vehicle is placed in motion.

(e) Release the engine clutch pedal and simultaneously increase the fuel feed.

To provide smooth starting, release the engine clutch pedal by not more than 2/3 of its travel, and when the vehicle is placed in motion, release the pedal completely.

To start the vehicle on an upgrade with the parking brake applied, do the following:

(a) Depress the engine clutch pedal.

(b) Shift in the first or the first low range gear depending on the angle of the slope and nature of the soil.

(c) Give a sound signal to warn that the vehicle is placed in motion.

(d) Holding the parking brake handle, turn it to the left.

(e) Increasing the crankshaft speed, release the engine clutch pedal and simultaneousl as the load rises, increase the fuel feed and shift the parking brake handle forward to a p sition at which the vehicle start is hardly noticeable.

Continuing to increase the fuel feed, quickly shift the parking brake handle all the w forward, and then turn it to the right and down. See that signal light panel RELEASE HAND BRAKE goes out.

CAUTION: Prevent the vehicle from moving back so as not to cause damage to the transmission mechanisms.

If the vehicle moves back, depress the engine clutch pedal and simultaneously brake the vehicle by pushing the stopping brake pedal; after that apply the parking brake. Start the vehicle again only after it comes to a full stop. Wi the vehicle moving back, never shift in gears.

To start the vehicle on a downgrade, with the brakes applied, do the following:

(a) Start the engine.

(b) Depress the engine clutch pedal.

(c) Shift in the required gear: first, second or third depending on the steepness of the slope, nature and state of soil; the steeper the slope, the lower the gear.

(d) Give a sound signal to warn that the vehicle is placed in motion.

(e) Holding the parking brake handle, turn it to the left.

(f) Release the engine clutch pedal and simultaneously shift the handle of the parkin brake all the way forward, and, varying the fuel feed, start motion. After that turn the parking brake handle to the right and down. See that signal light panel RELEASE HAND BRAKE goes out.

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16.2.4. Gear Shifting

Shift in gears by means of lever 37 (Fig.6).

Shift in the gears as follows:

- first gear - by pulling the lever upwards;
- second gear - by pushing the lever upwards;
- third gear - by pushing the lever downwards;
- fourth gear - by pushing the lever from the neutral position downwards;
- fifth gear - by pushing the lever from the neutral position upwards;
- reverse gear - by pulling the lever downwards.

Before shifting in the gears, depress the engine clutch pedal all the way down.

Shift in the reverse gear only after the vehicle has come to a full stop.

Shift in gears in a proper sequence. Shifting from a lower to a higher gear without engaging intermediate gears may lead to engine overload and stall, and shifting from a higher to a lower gear, to abrupt braking of the vehicle by the engine.

Do not shift gears, while moving over swampy terrain, deep snow, loose ground, ice and slippery ground, downgrades and upgrades, as well as while negotiating obstacles and fording.

In such cases shift in the required gear in advance.

If the engine speed decreases, with the fuel feed pedal fully depressed, shift in a lower gear,

While shifting from lower to higher gear:

(a) Smoothly accelerate the vehicle by increasing the speed of the crankshaft.

(b) Release the fuel feed pedal and simultaneously depress the engine clutch pedal all the way down.

(c) Shift in the next gear.

(d) Release the engine clutch pedal and simultaneously depress the fuel feed pedal so as to obtain the service speed of the engine.

To shift from higher to lower gear:

(a) Slow down the vehicle.

(b) Quickly depress the engine clutch pedal all the way down and simultaneously release the fuel feed pedal.

(c) Move the gearshift lever to engage the next lower gear.

(d) Release the engine clutch pedal and, simultaneously pressing the fuel feed pedal, make the engine reach a service speed.

Shifting in low range gears is accomplished by placing lever 15 (Fig.201) in the lower position.

It is recommended to use low range gears when manoeuvring on strictly limited sites and under especially heavy conditions. Besides, when a short obstacle is suddenly encountered do not engage a lower gear but use lever 15.

Before shifting in low range gears, slow down the vehicle, and before shifting in high range gears, accelerate the vehicle.

Shift lever 15 from one position to another without releasing the engine clutch pedal.

16.2.5. Turning the Vehicle

The radius of vehicle turn depends on the angle of the handle bar turn.

Turning the handle bar through a small angle causes the vehicle to make a smooth turn with a large radius, Turning the handle bar to the stop results in a sharp turn on the spot.

With the low range gear engaged, the vehicle may be turned only by turning the handle bar to the stop.

It is recommended to turn the vehicle on level stretches.

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Make smooth turn in any gear.

Make sharp turns on the spot in the first or second low range gear, first or second gear or in the reverse gear.

Never make sharp turns on the move in high gears since otherwise the tracks can be thrown off and the road wheel tyres can be damaged.

In the event of skidding, turn the vehicle in the direction of the vehicle's rear skidding.

On sand, loose and sod-clad soil, deep snow and mud, on upgrades turn the vehicle in several steps (depending on the nature and state of the soil). After each stop move the vehicle forward at least by half its length.

It is not recommended to turn the vehicle, while driving over boggy and icy ground.

Turn the vehicle on slippery ground in exceptional cases in the first, second and third gears, smoothly turning the steering handle bar and at the minimum recommended engine speed.

Avoid turns on steep upgrades, downgrades and slopes.

While moving, with the engine loaded to the maximum (the fuel feed pedal is depressed all the way down) turn the vehicle by slightly deflecting the steering handle bar without decreasing the engine speed before the turn. For making a sharp turn, be sure to shift into a lower gear.

16.2.6. Braking the Vehicle

The vehicle can be braked by the engine, stopping brakes or by the engine and stopping brakes simultaneously.

For braking the vehicle by the engine, decrease the fuel feed, i.e. reduce the engine speed; use this method of braking to slow down the vehicle in a column, on downgrades, while approaching the obstacles, while driving on slippery ground, before shifting in a lower gear and before stop.

Apply the stopping brakes to suddenly stop the vehicle.

Never brake the vehicle on the move by the parking brakes with the exception of those cases in towing when it is necessary to slightly brake the towed vehicle and thus to avoid collision of the towed and towing vehicles.

While braking the vehicle, avoid skidding of the tracks. Remember that the braking distance is directly proportional to the speed of movement and inversely proportional to the adhesive force. On wet and slippery sections of roads the braking distance is several times longer than on dry road.

Therefore, while driving the vehicle on slippery ground, do the following before sharply braking the vehicle: remove the foot from the fuel feed pedal at first and, without releasing the clutch, depress the stopping brake pedal, thus using the brakes and the engine simultaneously. In the event of skidding, release the brake pedal for a short time and then depress it again.

16.2.7. Stopping the Vehicle

The vehicle stop may be intended or sudden when the vehicle must be stopped all of a sudden.

To make an intended stop, proceed as follows.

(a) Slow down the vehicle by decreasing the engine speed. If necessary, slightly apply the stopping brakes simultaneously.

(b) Depress the engine clutch pedal all the way down.

(c) Place the gearshift lever in the neutral position and release the engine clutch pedal.

(d) Depress the stopping brake pedal, stop the vehicle and, if necessary, apply the parking brake.

Avoid prolonged halts on slopes.

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To suddenly stop the vehicle, proceed as follows:

(a) Abruptly release the fuel feed pedal.

(b) Depress the engine clutch pedal all the way down and simultaneously depress the stopping brake pedal.

While driving the vehicle over icy or slippery ground, at first depress the stopping brake pedal and then, after the vehicle has slowed down, depress the engine clutch pedal.

(c) Place the gearshift lever in the neutral position.

(d) Release the engine clutch pedal.

(e) After the vehicle has come to a stop, apply the parking brake and release the stopping brake pedal, if necessary.

16.2.8. Stopping the Engine

To stop the engine, proceed as follows:

(a) Run the engine for at least two minutes at a speed within 1500-1800 rpm and then decrease the speed before the stop to 800-1000 rpm. The temperature of the coolant before the stop should not be higher than +70°C.

At an ambient air temperature above +30°C it is allowed to stop the engine when the coolant temperature is not above +90°C.

(b) Release the pedal and turn in manual fuel feed control handle 43 (Fig.6) as far as it will go.

(c) Switch off the preheater water pump by pressing button 13 ENGINE COOLING SWITCH (ВЫКЛ. ОХЛАЖД.ДВИГАТ.) (Fig.246). See that lamp ENGINE COOLING (ОХЛАЖД. ДВИГАТ.) on the central panel goes out.

(d) Open the battery switch.

(e) Close the valve of the cylinder of the pneumatic system if the engine is stopped for a period exceeding two hours.

Open and close the cylinder valve by a slight hand effort. To fully open the valve, it is sufficient to turn the handwheel by 180-360°C.

If the engine stalls suddenly, try to start it immediately. If the engine fails to start, and the coolant temperature is above +70°C, do the following:

See whether the preheater water pump is started. If the pump is not started, close switch ENGINE COOLING (ОХЛАЖД.ДВИГАТ.) on the central panel.

At a coolant temperature in the range from +70° to +90°C the pump should run for no less than two minutes.

At a coolant temperature above +90°C the pump should run until the coolant temperature decreases down to +90°C.

To stop the engine without running it at an idle speed or without switching on the preheater water pump is not allowed so as not to cause inadmissible rise of its temperature after the stop, ejection of the coolant from the cooling system, and even breakdown.

16.2.9. Peculiarities of Vehicle Driving

While driving the vehicle over cross country, the driver should estimate the road conditions and change the travelling duty in due time in order to move in the permissible highest gear and at the maximum possible speeds.

While moving over bumpy roads, avoid sharp swinging of the vehicle, sharp blows of the road wheel arms against the stops. For this purpose slow down the vehicle and smoothly cross the bumps and the obstacles.

While approaching a bump, ditch, crater or other depression, decrease the fuel feed and, without depressing the engine clutch pedal, lower the vehicle to the bottom of the depression. If the vehicle accelerates, slow it down by the stopping brakes in order to prevent the hull from striking against the ground. As soon as the front road wheels come to touch the

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bottom of the depression, depress the fuel feed pedal and drive the vehicle out of the depression, paying particular attention to passing over the edge of the obstacle. As soon as the vehicle starts passing over the edge of the obstacle, decrease the fuel feed; after the vehicle has taken up the horizontal position, increase the speed, avoiding sharp blows and swinging of the vehicle hull.

If stumps, hummocks and other obstacles are smaller than the road clearance of the vehicle, leave them between the tracks. When doing so, do not turn the vehicle; otherwise, the tracks may be thrown off. If stumps and other vertical obstacles cannot be by-passed, run over them in the first gear with the tracks.

If the depth of the track equals or exceeds the road clearance, steer the vehicle so as to leave it between the tracks.

While moving over slippery roads at high speeds, observe the following rule: while applying the brakes, do not release the engine clutch till the vehicle slows down to a speed

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the engine, remove heaped sand from under the vehicle and clean the tracks, and only after that continue the movement.

While moving over bushy terrain, be sure to observe the road attentively since stumps, ditches, ravines and other obstacles may be concealed by the bushes.

On terrain where there are many boulders, rocks, stones and other obstacles, drive the vehicle with utmost care: avoid sharp turns, slow down the vehicle while approaching rocks and large boulders, and if possible, by-pass them or leave between the tracks.

If soil with stones is scraped by the tracks, clean the latter to prevent seizure of stones between the track and driving sprockets.

Driving the vehicle with the aid of vision device TBHO-2 is performed as follows.

Before placing the vehicle in motion, put the vision device in the operating position, for which purpose do the following:

- shift blind control lever 9 (Fig.121) in the CLOSED (ЗАКР.) position;
- close power pack switch 5; normal functioning of the vision device is proved by greenish glow of the image converter in the eyepieces;
- turn on headlight ФГ-125 with an infrared filter by switch 16 "TBH" (Fig.246) on the central panel;
- turn the blind control lever to the OPEN (ОТКР.) position.

Rules of driving the vehicle with the aid of night vision device TBHO-2 and day vision devices are the same. However, consider the following peculiarities:

(a) The images of the terrain and terrain features observed through device TBHO-2 are of one colour. The details of the objects are distinguished not by the colour, but by the intensity of luminescence which demands certain experience. Therefore, before the driver acquires such experience, he should drive the vehicle with particular care.

(b) The images of the terrain features and objects observed through vision device TBHO-2 are less bright and distinct than the images observed through the night vision devices, since the natural daylight provides better illumination than the sources of infrared light. Therefore, for better observation of the terrain features and objects, the operator's eyes must be get accustomed to the darkness, and the intensity of illumination inside the vehicle must be as minimum as possible.

(c) To keep the device from exposure to the light of the headlights, spotlights, lamps, flares and other sources of visible and infrared radiation, close the device blind by lever 9.

(d) While moving over winding roads or making sharp turns, observation through vision device TBHO-2 is difficult, therefore carefully watch the road signs and follow the traffic control man's commands.

(e) The turned-on infrared headlights may be easily detected by similar enemy's devices, therefore use them in case of necessity only.

The vehicle is capable of crossing water obstacles at a surface water state not in excess of Disturbance Scale No.2, stream velocity not in excess of 1.2 m/s. If the stream velocity exceeds 1.2 m/s, provision must be made for additional points of departure and towing facilities.

The vehicle carrying ammunition, fuels and lubricants, fully equipped crew and troopers, possesses positive buoyancy.

The vehicle is capable of crossing water obstacles when the fenders and guide vanes are broken, or not available; however, in this case, the speed of movement on water decreases, and manoeuvrability worsens.

While negotiating water obstacles, the personnel must wear life jackets.

The following conditions will provide rapid and successful crossing of a water obstacle:

(a) availability of relatively flat banks without slopes and other obstacles at points of entrace into and departure from water;

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(b) steepness of descent when moving into water should not exceed 25°-30° above water surface and 15° under water surface;

(c) steepness of climb when moving out of water should not exceed 20-25° above water surface, and 15° under water surface.

Before crossing a water obstacle, do the following:

(a) Make sure that the access hole covers and the plugs of the vehicle hull are available and tightly closed.

(b) Put the thimble of each wire rope on the front towing hooks, and place the wire ropes according to Fig.328 (Ref.No.12).

Using the cable wound on the buoy, fasten the latter to the front right-hand eye-bolt of the turret and fit on post 13.

(c) Install vision device ТНПО-350Б instead of driver's middle vision device ТНПО-170.

CAUTION: To prevent the gun from striking against device ТНПО-350Б, elevate the gun before traversing the turret.

(d) Before crossing a water obstacle at night, install headlight ФГ-126 on the turret for better illumination of the terrain.

(e) Check the engine protection valves, for which purpose:

(1) Open engine hatch 4 (Fig.14).

(2) With the engine shut down, prepare the engine protection valves for floating by turning handle 5 (Fig.15) downwards, and then upwards; after that, secure the handle in the clips.

(3) Close switch 23 FLOATING (ПЛАВ) (Fig.246). As a result, the engine protection valves close, and lamp 39 VALVE (КЛАПАН) lights up. Press handle 1 (Fig.193) of the valves by the hand to make sure that the valves come to rest against the seat under the action of the spring. If they fail, find out the cause of the trouble and adjust the control linkage.

Close the engine hatch, open switch FLOATING and prepare the engine protection valves for floating by turning handle 5 (Fig.15) downwards and then upwards; after that secure the handle in the clips. If during the check lamp VALVE fails to light up or handle 5 turns too easily, the valves prove to be open; in this case, find out and eliminate the trouble.

(f) Check the mechanisms used for lifting the air intake pipe, and splash panel, for which purpose shift handle 9 (Fig.6) of the interlocked pneumatic control cock in position IN WATER (ВХОД В ВОДУ), turn handle 14 of the splash panel control cock to position RAISED (ПОДН.) and make sure that the air intake pipe and the splash panel are raised.

(g) See that the canvas cover does not sag and does not brush against the raised air intake pipe when the turret traverses.

(h) The check over, press the head of handle 9 (Fig.6) and shift the latter to position OUT OF WATER (ВЫХОД ИЗ ВОДЫ); after the splash panel has been lowered, pull the head of the handle, place the latter in position LAND (СУША) and make sure that the dust suction valve is open, and the air intake pipe is lowered.

(i) Check, and if necessary, clean water drain valve 12 (Fig. 20) of the ejector by repeatedly opening and closing it through the cap.

(j) Check drain valve 52 (Fig.6) of the engine cooling system by pressing the cap several times. Check visually that both the valves are tightly closed.

(k) When the strength of the troop is not complete, arrange the troopers and the cargo (the weight of the cargo should not exceed the weight of the missing personnel) uniformly along the vehicle sides. Attach the cargo securely so as to prevent its displacement when the vehicle heels or trims.

(l) Open cover 21 (Fig.15) on the engine compartment bulkhead and check the tension of the compressor drive belts. The belt deflection should be within 15-22 mm. The check over, close the hatch.

(m) Make sure that the water discharge valves 13 (Fig. 303) of the water drainage pumps are clean and rise normally, for which purpose raise the valve discs by means of a screwdriver.

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(n) Remove the cover from the gun barrel.

(o) Dog down the rear doors, the driver's, commander's, operator's and troopers' hatches, and the firing ports for the small arms, make sure that ATGM feed hatch 13 (Fig.14) and the preheater boiler exhaust gas hole are reliably closed.

CAUTION: While dogging down the preheater hole cover, bear in mind that the hole cover axle has a left-hand thread.

The driver's hatch is dogged down by closing the lock at the left side of the hatch, and the rear doors, by turning the handwheel clockwise.

(p) Switch on the special blower. In this case make sure that filter ФПТ-200М is closed.

(q) Before crossing a water obstacle in winter time, remove the cover of access hole 7 (Fig.15) from the engine compartment bulkhead and close the air cleaner shutter by turning knob 3 (Fig.169) on the air cleaner wall as far as it will go in the direction shown by arrow CLOSED (ЗАКРЫТО) on the cover of access hole 7, and then close the access hole.

(r) Before prolonged floating check the hull for tightness (if this is possible) by moving the vehicle into water and keeping it there for 5-10 min.

Check the vehicle for water leakage visually and aurally, for which purpose shut down the engine.

(s) If the situation permits, it is recommended to fill the pedal bridge with lubricant; do it as follows:

(1) Remove covers 6 and 15 (Fig.15) from the access holes of the engine compartment bulkhead.

(2) Unscrew plug 34 (Fig.197) from the pedal bridge tube.

(3) Fill in solid oil by means of a grease gun until it is forced from under the tube bushing.

(4) Screw in the plug and close the access hole.

Directly before movement into water:

(a) Raise the splash panel and the air intake pipe, for which purpose shift handle 9 (Fig.6) of the cock in position IN WATER (ВХОД В ВОДУ), and set cock handle 14 in the RAISED position.

CAUTION: Never traverse the turret to direct the gun barrel backwards, with the air intake pipe raised. Do not forget that handle 9 can be shifted from the LAND position to the IN WATER position, and from the IN WATER position to the LAND position only through the OUT OF WATER position.

(b) Close switch FLOATING on the central panel, with the engine running.

(c) Start the rear and front water drainage pumps by switches 6 and 7 (Fig. 245).

When entering water:

(a) Enter the water, with the splash panel raised.

(b) Enter the water from a flat bank in the second gear at the engine speed not exceeding 1000-1200 rpm.

(c) Enter the water from a steep bank (more than 10-15°) in the first gear, slightly applying the stopping brakes so as to prevent the vehicle from rolling down the slope. The engine speed should not exceed 850-1000 rpm.

(d) After the front of the vehicle has submerged in water, it is recommended to release the engine clutch and simultaneously to stop the vehicle by the stopping brakes till the front of the vehicle emerges, and then continue the movement.

In floating:

(a) The higher permissible gear to be shifted in during floating, with the splash panel raised, is the third one.

With the splash panel lowered (both with the troopers and without them) the gear should not be higher than the second.

(b) Cross unreconnoitered water obstacles in the second gear. The speed of movement is controlled by changing the engine speed within 1500-2400 rpm.

(c) Engagement of the fourth and fifth gears is not allowed so as not to decrease the engine speed and increase the coolant temperature.

(d) During floating keep the engine speed near the maximum limit, except for the moments of gear shifting.

(e) For turning the vehicle and moving it in the reverse direction use the same controls and methods as on the land.

(f) If an under-surface obstacle is encountered, decrease the speed, and shift into the reverse gear and try to carefully leave the obstacle.

(g) If the splash panel is damaged, and the front of the vehicle starts submerging, rapidly release the engine clutch and shift in the second gear and continue the motion after the water drains off the front plate.

(h) When conducting fire from the gun or coaxial machine gun, with the vehicle afloat, lower the splash panel so as to protect it from being destroyed by the fire; for this purpose turn cock handle 14 (Fig.6) to the LOWERED position.

Before lowering the splash panel, shift in the second gear and reduce the engine speed down to 2000 rpm.

(i) If the engine protection valve closes at the moment of firing [signal lamp 39 VALVE (КЛАПАН) (Fig.246) lights up], set the valves for floating again, for which purpose shift handle 5 (Fig.15) down and up, and then secure it in the clips.

(j) If, when afloat, the engine stalls and the engine protection valves are caused to operate (signal lamp VALVE lights up), start the engine and only after that open the valves, for which purpose turn handle 5 (Fig.15) downward (the lamp should go out) and then upward; secure the handle in the clips.

CAUTION: If the engine suddenly stalls, make sure that the engine protection system has operated. Lamp VALVE must light up on the central panel. If the lamp glows, and the coolant temperature is not above +70°C, start the engine by the common method. Never make more than one attempt to start the engine and do not crank the engine without supplying fuel; otherwise, water may penetrate inside the engine and cause a hydraulic shock. If the coolant temperature exceeds 70°, cool the engine as stated in Subsection 16.2.8.
If the engine protection system has failed, or if one attempt to start the engine has been unsuccessful, tow the vehicle to the shore.

(k) If the vehicle is incapable of moving by its power, the crew must leave the vehicle through the operator's hatch, and the troopers, through the upper troopers' hatches.

On leaving the vehicle, close the hatches with a wrench to prevent the vehicle from sinking.

(l) If it is necessary to leave the moving vehicle, the troopers must come out through their hatches, close them, and leave the vehicle from the rear strictly in the backward direction so as not to be injured by the tracks.

If, when moving without the troopers (or without cargo), water leaks through the hull and its level reaches the lower edge of valve 2 (Fig.307), the driver should open this valve by pressing handle 4 and continue the movement.

If, with valve 2 opened, the water level keeps on rising, the driver should shift into neutral, set the engine speed within 2000-2200 rpm through the manual fuel feed control linkage, come out of the vehicle through the operator's hatch, close the latter by a wrench and prepare the vehicle for towing.

If the vehicle is rapidly filled with water, and the pumps fail to discharge the incoming water, the troopers are the first to leave the vehicle through their hatches and close them with a wrench; the operator and commander should escape through the operator's hatch.

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If possible, the driver should also escape through the operator's hatch; if there is no such opportunity, the driver is the last to escape through his hatch.

Before opening his hatch, the driver should undo the lock.

CAUTION: When afloat, never open the driver's, commander's and troopers' hatches (except for emergency cases); never open the doors and firing ports under any circumstances.

Drive the vehicle out of water, with the splash panel raised, in the second gear at a straight angle to the shore line. On the river, move the vehicle at an acute angle to the shore line, downstream, maintaining the maximum engine speed.

If, while climbing a steep bank, the engine stalls, brake the vehicle, start the engine and continue the movement.

If the vehicle must be moved back into the water, slightly brake it by depressing the engine clutch pedal in order to prevent free rolling.

On ascending the bank, lower the splash panel and the air intake pipe, for which purpose shift cock handle 9 (Fig.6) to position OUT OF WATER; after that, shift the handle into the LAND position.

Immediately on ascending the bank, do the following:

(a) Open switch FLOATING on the central panel and turn handle 5 (Fig.15) downwards.

(b) Remove vision device ТНПО-350Б and install device ТНПО-170.

CAUTION: Never shut down the engine till the water is completely removed from the ejector box.

To accelerate water discharge from the ejector, place the vehicle so that it heels to the right side. Make several sharp turns to the left on the move, or open the ejector water drain cock and valve.

For opening the cock, remove cover 23 (Fig.15) from the engine compartment bulkhead and turn ring 7 (Fig.184) (arranged in the ejector base to the left and above the access hole) clockwise. Then press and turn the cap of valve 12 (Fig.20) located on the floor of the fighting compartment.

(c) Switch off the front and rear water drainage pumps.

(d) Close the ejector water drain valve and cock.

At the first opportunity do the following:

(a) Untie the buoy from the turret eye-bolt, remove the towing wire ropes and stow them.

(b) Remove headlight ФГ-126 (if it has been installed) and stow it.

(c) If water has penetrated inside the vehicle, lubricate the pedal bridge.

(d) Drain water from the vehicle through the water drain hole, for which purpose place the vehicle, with the vehicle front raised. For draining the water, press the head of drain valve 2 (Fig.299) located on the floor of the troop compartment (at the rear).

If no water drains from the driving compartment, clean the passage under the cross beams.

To drain water from the engine compartment, open cover 21 (Fig.15) on the engine compartment bulkhead and remove remaining water by means of a syringe.

(e) In winter time turn handle 3 (Fig.169) on the air cleaner wall as far as it will go in the direction shown by arrow OPEN (ОТКРЫТЬ) provided on cover (Fig.15) of access hole 9 giving access to the shutter control handle.

16.2.10. Vehicle Recovery and Towing

When the vehicle is towed on land, observe the following rules:

(a) The driver's hatch of the towed vehicle should be closed;

(b) The turret must be locked, with the gun barrel directed forward or backward.

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(c) The speed of towing in day time should be within 10-12 km/h, and at night and u conditions of poor visibility, within 6-8 km/h.

Bear in mind, that, with the engine shut down, it is impossible to make turns.

(d) If the cylinder does not contain any compressed air (with the engine shut down) slow down the towed vehicle by slightly applying the parking brake.

(e) If the towing vehicle runs off the deep track, stop the movement, disconnect th towing wire ropes, return the towing vehicle to the track, connect the vehicles by the to ing wire ropes again and proceed with towing.

(f) As a rule, to use a similar vehicle as a tractor is not allowed.

(g) The towing wire ropes must be arranged in a criss-cross manner.

(h) During towing, avoid loosening of the towing wire ropes. To keep the wire ropes stretched, slightly apply the parking brake or stopping brakes through the pneumatic cont

(i) Start the vehicle smoothly, upon stretching the towing wire ropes.

(j) Shift in gears rapidly without slowing down the vehicle, and avoiding jerks. Shi in gear as rarely as possible.

(k) The driver of the towing vehicle must avoid sharp turns.

(l) Before the stop the driver of the towing vehicle must give a signal and smoothly slow down the vehicle so as to prevent collision of the vehicles and loosening of the wir ropes.

(m) For overcoming short but steep upgrades or driving over narrow passages across water obstacles, use long wire ropes so that the towed and towing vehicles are not on the obstacle simultaneously.

(n) Before towing, establish a system of signals between the towing and the towed vehicles.

As a rule, the infantry combat vehicles are towed on water by amphibious personnel c riers. In exceptional cases it is allowed to use a similar vehicle for the purpose.

Tow vehicles on water as follows:

(a) Before towing, prepare both vehicles for crossing the water obstacle.

(b) Connect the vehicles by standard wire ropes with the aid of one or two quick-detachable shackles 4 or 17 (Fig.328) in compliance with diagram "a" or "b". If a similar vehicle is employed for towing, use two quick-detachable shackles.

The shackle consists of two halves connected by axle 18. Both halves are connected by lock 19 fitted on axle 20. Fitted into the ear of the lock is rope(5)thimble whose free e holds handle 7. As the handle is pulled, the lock turns about the axle, and both halves of the shackle are uncoupled.

On the towed vehicle, connect the free ends of the wire ropes by means of the self-recovery wire rope or if the latter is not available, by the track pull-on wire rope.

When connecting the ropes by means of one quick-detachable shackle, pass handle 7 of shackle uncoupling rope 5 to the towing vehicle; when two shackles are provided, shackle uncoupling ropes handles must be kept on both vehicles.

(c) The crew of the towing vehicle must be especially attentive since the towed vehicle is uncontrollable. Approach the vehicle to be towed at the minimum speed and always be ready to shift into the reverse gear or make a turn so as to avoid striking the hull of the towed vehicle. In this case use posts, boat hooks, etc.

(d) If possible, start the towed vehicle engine and switch on the water drainage pumps perform the towing with the engine operating, to prevent the ejector from filling with water. Set the engine speed within 2000-2200 rpm by means of the manual fuel feed control linkage.

(e) If the engine of the towed vehicle is inoperative, keep the ejector from water as follows: close the ejector shutters and louvres and cover the ejector inlet and outlet ports with canvas mats.

(f) If the crew members and the troopers do not leave the vehicle, they must stay on the rear portion of the vehicle roof.

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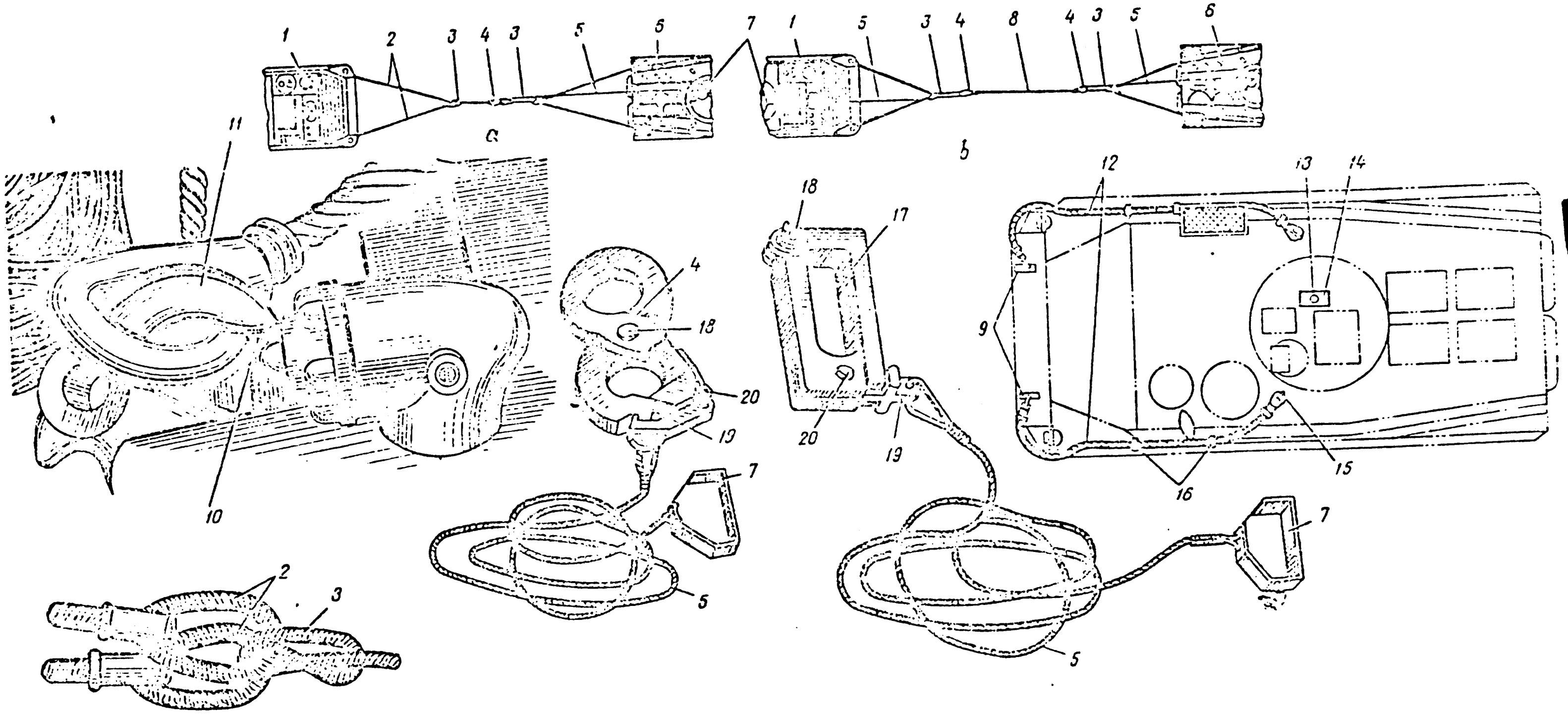
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FIG.323. VEHICLE TOWING, WHEN AFLOAT

a - coupling by means of one shackle; b - coupling by means of two shackles;
1 - towed vehicle; 2 - towing wire ropes; 3 - self-recovery wire rope; 4 - quick-detachable shackle of earlier make; 5 - ropes for uncoupling the shackle; 6 - towing vehicle; 7 - handles of shackle uncoupling ropes; 8 - wire ropes for mounting the track; 9, 11 - towing hooks; 10 - hook latch; 12 - stowage of towing wire ropes, when afloat; 13 - buoy securing post; 14 - buoy; 15 - wire rope end; 16 - wire rope clips; 17 - quick-detachable shackle of new make; 18 - shackle axle; 19 - shackle lock; 20 - lock axle

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(g) Select a speed of towing for the loaded vehicle (carrying the troopers) at which water does not flow over the splash panel.

(h) In the course of towing avoid loosening of the towing wire ropes. To prevent collision, use posts and boat hooks.

(i) For emergency uncoupling of the towing device, pull the handle of rope 5.

16.2.11. Self-Recovery

Self-recovery is used for salvage of stuck vehicles.

Self-recovery is effected by several methods:

- with the help of a log;
- with the help of two wire ropes; one end of each wire rope is fastened to a stationary object on the terrain or anchor, and the other end, to the tracks;
- with the help of two wire ropes when one or both tracks are off; one end of each rope is secured to a stationary object on the terrain, and the other end is fastened to a driving sprocket; the driving sprockets are used as winches.

The choice of self-recovery method depends on whether a log or wire ropes are available.

To perform self-recovery with the help of a log, do the following:

(a) Place a log, dia.200-250 cm, and 3-3.5 m long, on the ground close to the descending branches of the tracks on the side of the desired movement.

(b) Secure the log with the self-recovery wire ropes to both tracks. Wind the wire ropes around the log, and fit their loops on the track shoe shackles that are near the bearing surface of the tracks.

(c) Start the engine.

(d) Shift in the first gear or the reverse gear (depending on the direction of recovery).

(e) Place the vehicle in motion, avoiding jerks and misalignment of the log.

(f) Drive the vehicle and be ready to stop the vehicle on the commander's order.

(g) After the log comes from under the bearing surface of the tracks, brake the vehicle and shift into neutral.

(h) Disconnect the log.

If the vehicle has failed to reach hard ground or flooring, repeat the entire procedure.

As soon as the log comes from under the bearing surface of the tracks, stop the vehicle in due time in order to prevent the wire ropes from breaking and the fenders from damage.

16.2.12. Transportation by Railway

While loading the vehicle on a railway car, strictly observe the safety precautions and the rules of loading and unloading.

While preparing the vehicle for transportation:

(a) Carry out the routine inspection. In winter time the vehicle must be filled with winter fuel and low-freezing coolant. A plate with inscription COOLING SYSTEM IS FILLED WITH ANTIFREEZE (СИСТЕМА ОХЛАЖДЕНИЯ ЗАПРАВЛЕНА НИЗКОЗАМЕРЗАЮЩЕЙ ЖИДКОСТЬЮ) must be attached to the central panel.

(b) Make sure that the headlights and marker lights are reliably secured.

(c) Lock the turret.

(d) Close the trough-catch pawls on the round or dummy placed in the conveyer seat.

(e) Unlock the lever drive reduction gear.

(f) Directly before loading, remove the antenna and stow it.

To load and attach the vehicle:

(a) Place the vehicle on the car seeing that the track edges are at an equal distance from the edges of the car floor, and the space between the 3rd and 4th road wheels is over the middle of the car (Fig.329).

(b) Mark the points for attaching chocks 3.

(c) Move the vehicle backward by 1-1.5 m.

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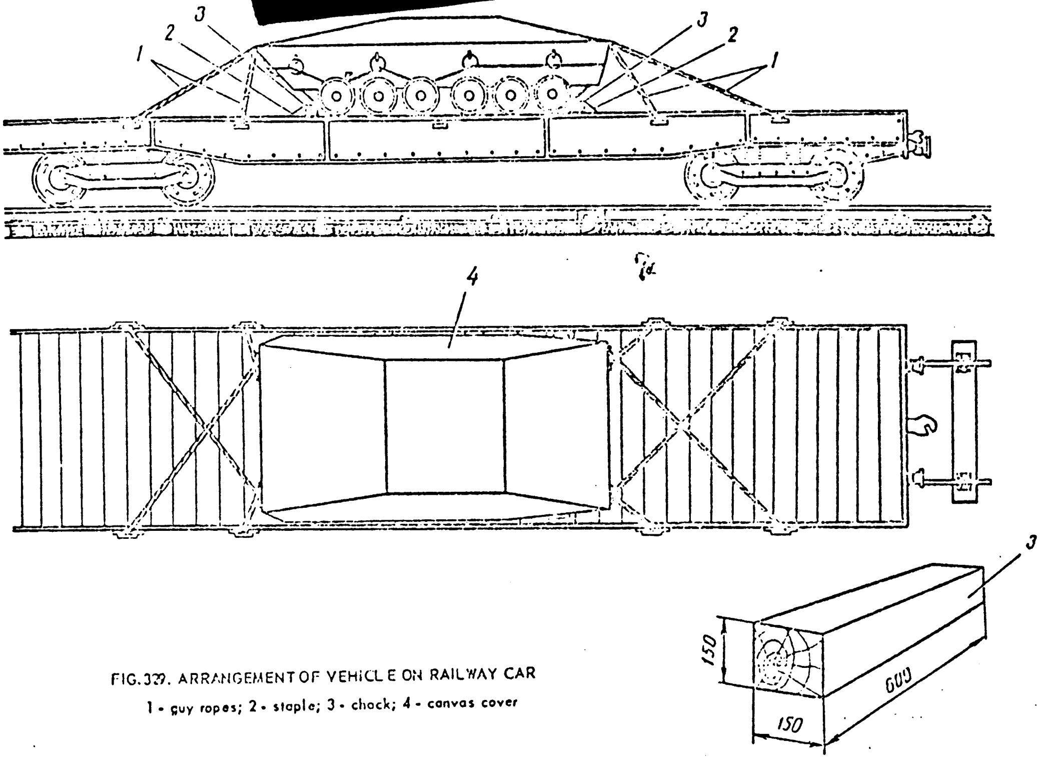

FIG.329. ARRANGEMENT OF VEHICLE ON RAILWAY CAR

1 - guy ropes; 2 - staple; 3 - chock; 4 - canvas cover

(d) Secure two front chocks 150x150x600 mm on the marked points with two staples 2, 14x125x250 mm.

(e) Move the vehicle forward, thrusting the front road wheels against the chocks.

(f) Secure the rear pair of chocks.

(g) Move the vehicle backward, stop it at an equal distance from the chocks, disengage the engine clutch; apply the parking brake and shut down the engine do not engage the reverse gear.

(h) Open the battery switch.

(i) Secure the vehicle with eight guy ropes 1, arranging the latter in pairs in a criss-cross manner.

The guy ropes are made of steel annealed wire, dia.6-6.5 mm. Each rope has no less than eight wires. The ends of the guy ropes are secured to the towing hooks of the vehicle and to the side hooks of the car if the load carrying capacity of the latter is 60 tons; if the load carrying capacity of the car is 20 tons, secure the guy ropes to the post seats

In transit, regularly check the vehicle for secure attachment and tighten up the guy ropes, if necessary.

(j) Close the vehicle with the canvas cover, having placed wooden pads on the sharp edges of the hull. Bind the canvas cover with wire.

To unload the vehicle:

(a) Remove the canvas cover.

(b) Remove the guy ropes from the towing hooks of the vehicle and side staples of the car.

(c) Remove the rear chocks and move the vehicle backward.

(d) Remove the front chocks and move the vehicle from the car onto the ground.

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16.3. PECULIAR FEATURES OF VEHICLE OPERATION UNDER VARIOUS CLIMATIC CONDITIONS

16.3.1. Vehicle Operation in Conditions of High Temperature

At high ambient air temperatures the units and mechanisms of the vehicle suffer heavier loads and the water in the cooling system and storage batteries evaporates more intensively. The viscosity of the oils and lubricants decreases, and leakages are most probable.

Besides, in conditions of high temperature the dust content in the air is rather high, and dust penetrates inside the vehicle and settles on the units, mechanisms, radiators, coolers and pipelines, impairing the heat transfer, increasing the efforts to be applied to the controls, and accelerating the wear of the rubbing parts. Apart from that, elevated temperatures and dust impair the operating conditions for the crew members and troopers. Dust settled on the vision devices impairs visibility, especially while moving in column.

While preparing the vehicle for operation in conditions of high temperatures carry out preventive maintenance No.1 and No.2 and additionally do the following:

Close the winter air intake shutter to stop air supply from the ejector box to the air cleaner. For this purpose, open the cover of access hole 9 (Fig.15) on the engine compartment bulkhead and turn handle 3 (Fig.169) as far as it will go in the direction shown by arrow CLOSED (ЗАКРЫТО) provided on the cover of access hole 9 (Fig.15), lock handle 3 (Fig.169) with wire.

Fill the fuel system with summer diesel fuel. It is allowed to completely use the winter fuel contained in the fuel system or to add summer fuel to the tanks containing winter fuel.

Fill the cooling system with water containing a three-component additive. Drain the low-freezing liquid into a clean vessel.

To drain the liquid, open the cock by turning handle 13 (Fig.15), press the cap of coolant valve 52 (Fig.6) having placed a clean vessel under the vehicle bottom.

Move cleaners 20 (Fig.218) as far from the idler wheel rings as possible.

Fill water into the tank for air-and-liquid cleaning of the vision devices.

Wipe the wells and locating places of vision devices ТНПО-170 with clean waste.

Check the electrolyte density and level in the storage batteries.

Weigh the cylinders of the fire-fighting equipment. The weight of the cylinder should be in the range from 1.21 to 1.35 kg.

Adjust the sight objective in the NIGHT mode of operation. For this purpose, unscrew the cover bearing inscription FOCUSING (ФОКУСИРОВКА) from the front side of the sight and turn the splined shaft with a screw-driver clockwise till the white mark is aligned with the red point on the sight body.

Replace the winter headsets by the summer ones.

Examine and, if necessary, mend the canvas cover for the vehicle and the winter mats.

Check the water radiator and the oil cooler for cleanliness, and, if necessary clean them and blow out. Check the pipelines and their connections for condition.

Check the vacuum-and-pressure relief valve.

If the engine has been running under high temperature conditions, wash the cooling system.

To this end, proceed as follows.

Fill the cooling system with water containing a three-component additive - a mixture of potassium bichromate (GOST 2652-48), sodium nitrite (GOST 6194-52) and trisodium phosphate (GOST 201-58); the weight of each component is 0.05% of the filled water (1 g for two litres of water). Pour the additive by small portions into boiled water heated to 60-80°C and stir the solution thoroughly.

It is allowed to pour the additive components directly through the filler neck. Do it, with the engine running, at the water temperature in the range from 40 to 60°C. The additive is fully dissolved for 10-15 min.

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While operating the vehicle at high temperatures and in dust-laden atmosphere observe the following rules.

Thoroughly watch the coolant and oil temperatures, seeing that they do not rise above the permissible limits. Regularly check to see that the cooling system is filled up, check the water radiator and oil cooler for cleanliness and the engine compartment bulkhead seals for condition.

If the coolant temperature exceeds the permissible limit, shift into a lower gear and increase the engine speed. If the oil temperature exceeds the permissible limit, shift into a lower gear and establish the minimum permissible speed of the engine.

At halts, check to see that the units of the power transmission and running gear are not overheated.

Fill in fuel and oil through a hose. Prior to doing so, clean the plugs of the filler necks from dust.

Take measures to prevent penetration of dust in the filters and air cleaner during their maintenance. Upon disconnection, close the filler necks and pipelines with clean waste.

Remove grease from the open rubbing elements: toothed sectors, gears and guides and regularly wipe them so as to avoid corrosion.

If the efforts required to move the pedals and levers become higher than normal, wash the hinge joints and bearings with diesel fuel. Upon washing, lubricate the bearings with grease УТ-1 (GOST 1957-52). Do not lubricate the hinge joints.

At least every 15 days check the electrolyte level in the storage batteries, and, if necessary, add distilled water. Clean the vent holes in the plugs. Wipe the sealing compound with clean waste slightly wetted with 10% solution of ammonia spirit.

While moving in a column over dusty roads and against the wind, observe the following rules.

(a) Do not move in line with a preceding vehicle so that the dust raised by the latter does not settle on the vision devices or on the driver's hood glass.

(b) If under given road conditions it is impossible to keep the vehicle out of line with the preceding vehicle, increase the distance between them so as to ensure safety of movement.

(c) Turn on the marker lights.

(d) While travelling, put on the driver's protective hood.

16.3.2. Vehicle Operation at Low Temperatures

Low ambient air temperature impairs the operating conditions for the vehicles, its mechanisms and units, as well as for the crew.

It is difficult to drive the vehicle over snow, icy roads and frozen hard ground. Frozen glasses of the vision devices, falling snow and ground features hidden under snow are the reasons for difficult orientation, poor visibility; under such conditions all the crew members must be especially attentive when on the move and when conducting fire.

Under low-temperature conditions carry out preventive maintenance No.1 or No.2 and additionally do the following.

Replace the summer fuel in the fuel system by winter or arctic fuel (depending on the temperature conditions).

Clean the wells and the locating places of vision devices ТНПО-170 and wipe them with clean waste.

Open the winter air intake shutter to supply the air from the ejector box. To this end, open the cover of access hole 9 (Fig.15) on the engine compartment bulkhead and turn handle 3 (Fig.169) as far as it will go in the direction shown by arrow OPEN (ОТКРЫТО) provided on the cover of access hole 9 (Fig.15).

Drain the water and fill the cooling system with low-freezing liquid in compliance with the expected temperature conditions:

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liquid, grade "65", for temperatures below -30 to -35°C;
liquid, grade "40", for temperatures above -30°C.

The coolant level must be against the end of the lower rib of dipstick 4 (Fig.178), o 80 mm below the upper edge of the tank filler neck.

Check the preheating system for reliable operation, as pointed out in Subsection 16.2.

Position the cleaners so that the distance between the latter and the idler wheel rim is within 3 to 5 mm.

Drain water from tank 32 (Fig.127) of the vision device air-and-liquid cleaning syst and blow out the system with compressed air, for which purpose press button CLEANING (ОЧИС KA) under cover 22 (Fig.246) on the central panel ten times.

Check the electrolyte density in the storage batteries.

Adjust sight objective focusing in duty NIGHT (НОЧЬ); for this purpose, unscrew the c with inscription FOCUSING (ФОКУСИРОВКА) (Fig.97) and turn the splined shaft counterclockwi till the white notch is aligned with the white spot on the sight body.

Measure the voltage maintained by the regulator. At the engine service speeds the voltage must be in the range from 26.5 to 28.5 V.

Make the measurements with the help of a voltammeter.

To keep the engine ready for start at halts in low-temperature conditions, do the follo

(a) Select a ground for parking, seeing that it is protected against wind.

(b) Close the hatches and the rear doors. Close the ejector shutters and louvres, for which purpose place latch 11 (Fig.180) in the vertical position and turn handle 10 to upper position CLOSED (ЗАКРЫТО).

(c) Close grills 1 over the louvres and the ejector shutters with mats.

(d) Close the vehicle with the canvas cover and tie it up with rope.

If the coolant temperature decreases below 35-40°C, start the preheater and heat the coolant to 80-90°C. On using the preheater for two times, boost-charge the storage batterie from the engine generator.

CAUTION: 1. If the cooling system is filled with water, and the water temperature drop down to +60°C, heat the water to +90°C.
2. Switch on the heaters for heating the air inside the vehicle, only with th engine running.

To switch on the heaters, proceed as follows.

(a) Switch on the special blower of the filter-ventilating unit, for which purpose set switch SPECIAL BLOWER (НАГНЕТАТЕЛЬ) on the central panel in the ON position. Before switching on the special blower, make sure that the valve of filter ФПТ-200М is closed, and lamp ФПТ FILTER VALVE OPENED (ОТКР. КЛАПАН ФПТ) is dark.

(b) Set the handle of heater cock 20 (Fig.176) in the L.H. bay behind the commander in the OPEN (О) position.

Set switch 18 (Fig.227) of the troop compartment heater (on the rear wall of the stora battery compartment) in the ON position.

To cut off the heaters, open the switch and set the cock handle in the CLOSED ("З") position.

When using the system of vision device heating adhere to the following procedure.

(a) To avoid battery discharge, do not switch on the heaters with the engine shut dow Switch on the heaters with the engine shut down in exceptional cases only for a short peri of time.

(b) The duration of continuous heating of the protective glass of commander's device ТКН-3Б (К-3Б) and firing port glasses at an ambient air temperature of -5°C and below is not limited.

(c) At an ambient air temperature in the range from -5°C to +20°C the duration of heating should not exceed 10 min.

At an ambient air temperature of -10°C and below it is recommended to heat the inner glasses of vision devices ТНПО-170 only.

(d) For the procedure of switching on the vision device heating, see Section 5.

When operating the vehicle under low-temperature conditions observe the following rules

While moving over deep snow, try to follow the track of the preceding vehicle at such a distance that the snow thrown by the tracks of the preceding vehicle could not impair the visibility.

If the vehicle gets stuck in snow, try to move the vehicle backward. While doing so,ke the vehicle from digging into the snow and see that the vehicle bottom does not rest on hard snow.

Do not make sharp turns and see that snow is not scraped into the tracks. For making a sharp turn, alternate short turns with straight-forward movement. If possible, turn the vehicle in the reverse gear.

While moving over icy roads in a column start climbing only after the preceding vehicle has completed climbing.

While moving at high speeds over slippery roads, do not make sharp turns, do not releas the engine clutch before braking and do not brake the vehicle abruptly. To stop the vehicle suddenly, brake it by the engine and stopping brakes simultaneously.

Before making a long halt, select a high place protected from wind and take measures to prevent sticking of the tracks to the frozen ground. Close the vehicle with the canvas cover and the ejector louvres and shutters with mats.

At extreme low temperatures remove the storage batteries from the vehicle and keep them in a heated place.

Before making a long halt, check to see that the cylinder is charged with compressed air, and, if necessary, bring the pressure to normal.

After the engine has been started and the vehicle has been warmed up after a long halt at extremely low temperatures, drive the vehicle in low gears for the first 10-15 min in order to warm up the units of the running gear.

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16.4. VEHICLE MAINTENANCE

16.4.1. General

To keep the vehicle in good operating condition and constant combat readiness, carry out the maintenance of the following types:

Routine inspection is carried before leaving the park or before the combat, the purpose of inspection is to check the vehicle for serviceability and to add the necessary service materials.

Approximate duration of inspection is 15-20 min.

At halt inspection is carried out every two or three hours of movement.

Approximate duration of inspection is 10-12 min.

Daily maintenance (DM) is carried out upon vehicle return to the park or upon fulfilment of the mission, irrespective of the kilometrage covered.

Approximate duration of maintenance is 2.5-3.0 hours.

Preventive maintenance No.1 is carried out every 2500-2600 km of run.

Approximate duration of maintenance is 5.5-6.0 hours.

Preventive maintenance No.2 is carried out every 4800-5000 km of run.

Approximate duration of maintenance is 7.5-8.0 hours.

Recommended Service Materials

Summer diesel fuel ДЛ, GOST 47-49.
Winter diesel fuel ДЗ, GOST 47-49.
Arctic diesel fuel ДА, GOST 47-49.
Fuel T-1 and T-C (GOST 10227-62) for jet engines.
Oil МТ-16п, GOST 6360-58.
Oil МТ-14п, GOST 6360-58.
Oil МТ-16п, РТУ РСФСР No.ПП-27-62.
Oil МТ-8п, МРТУ, No.38-1-151-64.
Multi-purpose high-melting lubricant УТ-1, GOST 1957-52.
Solid oil "C" (automobile lubricant УСс), GOST 4366-64.
Lubricant ЦИАТИМ-201, GOST 6267-59.
Lubricant ЦИАТИМ-208, GOST 16422-70.
Gun grease (lubricant УНЗ), GOST 3005-51.
Transformer oil ТКп, GOST 982-68.
Transformer oil, GOST 10121-62.
Turbine oil 22 (turbine oil Л), GOST 32-53.
Lubricant УН, GOST 782-59.
Lubricant ГОИ-54п, GOST 3276-63.
Low-freezing liquid, grade "40" or "65", GOST 159-52.
White spirit, GOST 3134-52.
Gasoline, grade Б-70, GOST 1012-54.

16.4.2. Routine Inspection Before Leaving the Park

Operations to be fulfilled	Instructions and materials used
1. Make sure that fuel system is filled to capacity	If necessary, replenish system up to filler necks of main tank and tanks at doors
2. Make sure that engine lubricating system is filled to capacity.	Oil level must be against upper mark of dipstick. Top up, if necessary. Minimum permissible amount of oil in tank is 20 lit
3. Make sure that expansion tank of cooling system is filled to capacity	Level of water containing three-component additive should be at the end of middle rib of dipstick, or be 65 mm below upper edge of tank filler neck, if necessary replenish.

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Operations to be fulfilled	Instructions and materials used
	Capacity of cooling system is 50 lit. Level of low-freezing liquid, grade "40" or "65", must be against the end of lower rib of dipstick or be 80 mm below upper edge of tank filler neck. If necessary, replenish
4. Check steering handle bar, pedals and control levers for action	Steering handle bar, pedals and control levers must move easily. Pedals should return to initial position, when released
5. Check external lights and horn for condition	Perform the check by turning on the consume in succession. Replace burnt-out lamps
6. Check hatch doors, access hole covers and plugs on vehicle hull and bottom for presence and attachment	Inspect externally. If necessary, secure doors, covers and plugs reliably
7. Check SPTA set for secure attachment outside the vehicle	Inspect externally. Secure, if necessary. Covers of boxes with SPTA set must be locke
8. Check track shackles and wedges with nuts for presence and condition	Inspect externally. Eliminate troubles detected
9. Prepare engine for starting, start it, warm up and check:	
(a) engine run at speed within 2000-2600 rpm	Prepare, start and warm up engine, as instr ed in Section 16
(b) instruments for normal functioning	Check instruments externally by deflection of pointers
(c) presence of charge current and value of mains voltage	Mains voltage must be in the range from 26.5 to 28.5 V
10. Check fuel, lubricating and cooling systems for leakage	Inspect engine compartment through access holes in engine compartment bulkhead
11. Before leaving the park at night place device TEH-2 in operating position and check it for serviceability	Proceed as outlined in Subsection 5.4.7
12. Wipe optical parts of sight, device TEH-35 and vision devices	Wipe with clean flannel cloth
13. Check the controls on sight control panel for normal functioning both in day and night modes of operation	Perform check as outlined in Section 5. Check over, set the controls in initial positi
14. In anticipation of firing the gun, and machine gun, do the following:	
(a) Make sure that gun is automatically locked at angle of loading and remove lubricant from barrel bore	Place switches LM and DRIVE in position ON, set levers, with trough-catch lugs closed, in intermediate position and press button "K" or "O". As soon as levers move down, place levers LM and DRIVE in position OFF and, using manual drive of elevating mechanism, make sure that gun is locked
(b) Check gun electric primer circuit for condition	Perform check as pointed out in Subsection 3.4.4

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Operations to be fulfilled	Instructions and materials used
(c) Check amount of fluid in hydraulic recoil brake of gun	Perform check as pointed out in Subsecti 3.2.5
(d) Check machine gun electric trigger and remove lubricant from barrel bore and movable parts	Perform check as pointed out in Subsecti 3.3.4
(e) Check ammunition for proper stowage and fastening	Rounds must be clean and securely held i stowage place
(f) Check loading mechanism conveyor race and remove foreign matter from it	Check externally
(h) Check position of trough-catch	Trough-catch should be closed on round in conveyer. Trough-catch tube must be fixed lower lock
(i) Check laying drive 1ЭЦ10М	Perform check as outlined in Subsection 4
15. In anticipation of launching 9М14М:	
(a) Check handle 3 (Fig.69) of ATGM control panel, switch 5, cap of signal lamp 6, button 2 and protectors	Handle should easily move to either side from neutral position: when released, it should energetically return to neutral posi Switch 5 must be reliably fixed in all positions. When button 2 is depressed, click should heard. Cap and protectors should be intact
(b) Check and, if necessary, adjust clearance "V" (Fig.68)	Perform check and adjustment as stated in Subsection 3.5.10
(c) Make sure that cover 10 (Fig.66) is reliably attached to launching bracket	Secure cover, if necessary
(d) Check guide rail for secure attachment in stowage places	Secure, if necessary
16. In anticipation of transportation by air:	
- remove stoppers from aviation cartridges 41 (Fig.97) on sight and spare head cover	After transportation by air reinstall sto
17. Make sure that turret can be properly locked	Perform check by engaging and disengaging
18. See that handle 8 (Fig.116) of swivelling mirror of device ТКН-3Б is set in position "Д" (for movement in daytime)	Install handle, if necessary

16.4.3. Routine Inspection at Short Halts

Operations to be fulfilled	Instructions and materials used
1. Make sure that covers and plugs on hull and bottom are not missing	Examine externally. If necessary, secure covers and plugs
2. See that boxes with SPTA set are reliably secured inside and outside the vehicle	Inspect externally. If necessary, secure boxes

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Operations to be fulfilled	Instructions and materials used
3. See that connections of engine systems and power transmission are not leaky. See also that pipelines are not damaged because of rubbing	Inspect externally through engine access hatch and access holes of engine compartment bulkhead. On detection of leakage, check fuel, oil or coolant level and replenish respective system, if necessary
4. Check marker and signal lights for condition	Perform check by turning on lights in succession. Replace faulty lamps
5. Clean air intake pipe screen and water radiator and oil cooler screens	Do it, while driving over woody terrain, and after crossing it (especially in autumn)
6. Remove condensate from moisture-and-oil separator	Open cock 46 (Fig.6) of moisture-and-oil separator for 10-20 s and remove condensate, with engine running at 2200-2600 rpm
7. Check tracks for condition	Inspect externally. Eliminate troubles detected
8. Make sure that caps and plugs of lubricating holes in units of running gear are reliably secured	Inspect externally. Tighten up loose bolts and plugs
9. Clean guide vanes of fenders	Do it when moving over dirt or snow is compl
10. Check systems of power plant and power transmission for leakage	Inspect bottom through access holes of engin compartment bulkhead. In case of leakage, check oil level in tank and in gear case, as well as coolant and fuel levels
11. Wipe glasses of sight and vision devices	Wipe with flannel cloth
12. Check ammunition for proper attachment	Inspect externally
13. Remove foreign matter from loading mechanism conveyer race	

16.4.4. Daily Maintenance, Preventive Maintenance No.1 and No.2

The operations to be performed are designated in the table by "0", and operations not to be performed, by sign "-".

The figures in brackets indicate the Ref.Nos in the Lubrication Chart (Fig.333)

Operations to be fulfilled	Types of maintenance			Instructions and materials used
	DM	No.1	No.2	
1	2	3	4	5
		Whole Vehicle		
1. Check fuel level in vehicle fuel feed system	0	0	0	Fill in fuel till lower edge of tank filler neck is reached. See Subsection 6.3.14
2. Check oil level in tank of engine lubricating system (3)	0	0	0	Add oil up to upper mark of dipstick. See Subsection 6.5.4
3. Check coolant level in expansion tank of engine cooling system,	0	0	0	Add coolant, as pointed out in Subsection 6.6.4

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1	2	3	4	5
4. Clean vehicle of dust in summer and of snow in winter	0	0	0	Before washing, cover injector inlet and outlet ports with mats, close valves of exhaust blowers and special blower
5. Clean inside of vehicle from dust and dirt with waste soaked in water	0	0	0	Before cleaning, inspect interior of vehicle for oil (liquid) leakages. Never wash the inside of vehicle by means of hose nor discharge water by use of water pumps after washing. While washing the vehicle with the use of bucket, drain water through hole (valve) in bottom of troop compartment
6. Check covers and plugs on hull and bottom for secure attachment	0	0	0	Covers and plugs must be tightened up
7. Clean air intake pipe screen from dust and dirt	0	0	0	Clean screen, with engine shut down. Screen must be clean and free from damage
8. Remove dust from fighting and troop compartments	0	0	0	Switch on exhaust blowers for five minutes
9. Lubricate hinge joints of access hole covers and hatch doors (7)	-	0	0	Lubricate hinge joints with oil MT-16п with use of grease gun
10. Remove dirt and sediment from non-return valves 5 (Fig.305) of water drainage pump outlet pipes	0	0	0	Use wooden sticks and waste for the purpose
11. Wash locks 23 (Fig.22) with diesel fuel and lubricate with oil MT-16п through holes (7) of handles	0	0	0	Wash by means of grease gun if locks function abnormally
12. Wash inner spaces of door outer handles (7)	0	0	0	Wash with diesel fuel by means of grease gun, with doors opened. While doing so, keep door sealings from fuel. Wash inner space when handles rotate with difficulty
13. Check SPTA set for secure attachment outside vehicle	0	0	0	Inspect externally. Secure, if necessary
14. Check SPTA set and standard equipment for presence and secure attachment inside vehicle	-	0	0	Inspect externally. Replenish equipment as required
15. Wipe glasses of vision devices and ball supports	0	0	0	Wipe with flannel cloth
16. Lubricate hinge joints of access hole covers and hatch doors	-	0	0	Lubricate hinge joints with oil MT-16п in case of jamming

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1	2	3	4	5
17. Check antenna assembly: see that locks are sound, and antenna is in good condition. See also that antenna assembly is free from dirt and water	0	0	0	Clean with dry clean waste. Never wash insulators with fuel and oil
18. Clean starting and control equipment from dust	-	0	0	Use brush for cleaning
19. Drain sludge from main tank of fuel system	-	-	0	Drain five or six litres of fuel, as pointed out in Subsection 6.3.14.
20. Inspect commutators and brushes of electric motors МУ-431, Д-55 and convertor ПАГ-10	-	-	0	Remove protective band, remove dust with clean dry compressed air. Wipe commutator with clean cloth slightly wetted with gasoline. If height of brushes is as low as 10 mm, replace brushes
21. Remove dust and dirt from sight and device ТКН-35	0	0	0	Wipe glasses with clean dry flannel cloth, and bodies with waste
22. Check desiccators 38 (Fig.97) in sight and also in device ТКН-3Б and in SPTA set for condition	0	0	0	Silica gel should be blue. If silica gel is pink, replace desiccator or recondition it, as pointed out in Subsection 5.2.7
23. Check protection system for reliable functioning	-	0	0	Perform check as stated in Subsection 11.5
Running Gear				
24. Check to see that nuts 42 (Fig.218) of track wedges 43 are present and properly tightened	-	0	0	Perform operation every 1200-1300 k of run during scheduled preventive maintenance, without removing tracks from vehicle. Make sure that nuts are properly tightened with use of wrench, applying 35 kgf force on 400-mm long arm. Traces left by driving sprocket rings on wedge securing nuts are allowed
25. Check tracks for tension	-	0	0	Perform operation every 1200-1300 km of run during next scheduled preventive maintenance. If track is normally tightened, its deflection between thread and pin inserted in track shoe hole is 6-8 mm. If necessary, adjust tension of tracks as outlined in Subsection 8.4.2
26. Check fluid level in hydraulic shock absorbers (13)	-	0	0	Check and replenish shock absorb as outlined in Subsection 8.4.8 (four lubrication points)

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1	2	3	4	5
27. Lubricate journals of front tubes of road wheel arms (12)	-	0	0	Add solid oil "C" every 1200-1300 km of run simultaneously with next daily maintenance, and every preventive maintenance No.1 and No.2; do it by means of grease gun till lubricant appears in level hole (two lubrication points)
28. Lubricate journals of road wheel arm tubes (12) (except for front ones)	-	0	0	Add 100-160 g of solid oil "C" in each point by means of grease gun (ten lubrication points)
29. Check oil level in support rollers (11),	-	0	0	Oil level must be against lower edge of filling hole. Add oil МТ-16п by means of grease gun (six lubrication points)
30. Check oil level in road wheels (10)	-	0	0	Oil level must be against lower edge of filling hole. Add oil МТ-16п by means of grease gun (twelve lubrication points)
31. Check oil level in idler wheels (9)	-	0	0	Oil level must be against lower edge of filling hole. If necessary, add oil МТ-16п by means of grease gun (two lubrication points)
32. Check oil level in track adjusting mechanisms (8)	-	0	0	Oil level must be against lower edge of filling hole. If necessary, add lubricant ЦИАТИМ-208 by means of grease gun (two lubrication points)
33. Lubricate upper and lower ears of hydraulic shock absorbers (13)	-	0	0	Add grease УС by means of grease gun till it comes out of gaps. For lubricating lower ears use pipe union kept in SPTA set
34. Check driving sprocket securing plugs 11 (Fig.220) and driving sprocket ring bolts 5 for secure attachment.	-	0	0	Plugs and bolts must be tightened up securely, if otherwise, tighten them up
35. Interchange driving sprockets	-	-	0	If necessary, interchange the right-hand and left-hand sprockets. While interchanging driving sprockets, lubricate final drive carrier shaft with grease УС
36. Check road wheel hub caps and filling plugs for secure attachment	0	0	0	Inspect externally and tap on bolts; if necessary, tighten up bolts

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1	2	3	4	5
		Engine Compartment		
37. Check fuel injection pump, oil and water pumps, fuel and oil filters, generator, starter, tachometer generator, air distributor, intake and exhaust manifolds	-	-	-	Perform operation after initial 1200-1300 km of run simultaneously with next scheduled daily maintenance. Inspect externally and check by touch. If necessary, tighten up connections
38. Check tension of compressor drive belts	0	0	0	Tension of both belts must be similar. Adjust belt tension, as instructed in Subsection 15.3.3, if necessary
39. Add grease to bearings of compressor drive pulley and tightening roller (6)	-	-	0	Perform operation every 8000 km of run and at least once every four years. For lubricating procedure, see Subsection 15.3.6
40. Start engine and check it for normal performance aurally and with the aid of instruments	0	0	0	Do it if running was abnormal during movement. Check engine for performance while checking it for leakages after washing of filters

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1	2	3	4	5
				Check oil level and, if necessary, replenish final drive housing as pointed out in Subsection 7.5.2. (two lubrication points)
48. Renew oil in final drive housings	-	-	0	Renew oil as pointed out in Subsection 7.5.2
49. Pack grease in bearing of engine clutch release mechanism (4)	-	-	0	Pack 60 g of grease УТ-1, as pointed out in Subsection 7.2.7
50. Check oil level in fuel injection pump governor (5)	0	0	0	Perform operation every 1200-1300 km simultaneously with scheduled preventive maintenance. Perform the operation after every 1200-1300 km of run simultaneously with scheduled preventive maintenance. Oil level must be against upper mark of dipstick. Check and, if necessary, top up oil as instructed in Subsection 6.5.4
51. Renew oil in fuel injection pump governor (5)	-	-	0	Renew oil if it is diluted or badly contaminated. Do it as pointed out in Subsection 6.5.4
52. Renew oil in engine lubricating system	-	0	0	Renew oil every 5000 km of run, and at least every 250 hours of engine operation. When fuel TC-1 or T-1 is used, renew oil every 2500-2600 km of run, and at least after 120 hours of engine operation. Renew oil in due time irrespective of the duration of engine operation on diesel fuel. For the renewal procedure, see Subsection 6.5.4.
53. Wash centrifugal oil filter of engine lubricating system	-	0	0	Perform operation every 2500 km of run, and at least after 120 hours of engine operation. Wash centrifugal filter following procedure of Subsection 6.5.4. Wash coarse filter simultaneously with centrifugal oil filter, as pointed out in the same Subsection
54. Wash coarse fuel filter	-	0	0	Wash filter as pointed out in Subsection 6.3.14. Wash fine fuel filter 500 hours of engine operation and also when engine power considerably decreases. Do it as stated in Subsection 6.3.14
55. Disassemble and, if necessary, wash non-return valve of smoke-generating equipment	-	-	0	Perform operation, as pointed out in Subsection 13.4
56. Clean outside of water radiator and oil cooler.	-	-	0	Blow off with compressed air or wash with water.

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1	2	3	4	5
Check, and, if necessary, reliably secure pipelines to radiator and cooler				Wash radiator and cooler with water spray, with engine runnin at speed of 1800 rpm, roof remo air cleaner dust suction valve closed, air cleaner intake shut placed in position CLOSED (3AK and ejector water drain valve o ed
57. See that engine-to-gear-box securing bolts are tightened up	-	-	0 -	Check by means of 22-mm chang head and wrench 27-32 mm. Loose joints are not allowed
58. Wash air filter of air pressure control unit АДУ	-	-	0	Wash every 8000 km of run sim taneously with scheduled preven maintenance, as pointed out in Subsection 15.3.2
59. Wash filter of oil priming pump IBH	-	-	0	Perform operation, as pointed out in Subsection 6.5.4
60. Wash hydraulic vortex tube of gearbox	-	-	0	Wash every 8000 km of run sim taneously with scheduled preven maintenance as pointed out in Subsection 7.6.3
61. Clean louvres control linkage, ejector shutters, and louvres axles	-	-	0	Perform operation as pointed in Subsection 6.6.4
62. Drain condensate from settler 16 (Fig.308) of engine compressed air starting pipeline	-	-	0	Open cover of access hole 6 (Fig.15), and using, wrench, unscrew plug 3 (Fig.190) of sett
63. Examine generator commutator and clean it	-	-	0	Remove protective band. Clean commutator with cloth slightly soaked in gasoline. If dirt woul not be removed, use glass paper "00". Before doing so, remove brushes from brush holders. Whil cleaning commutator, rotate generator armature (crank engine)
64. Check generator brushes for condition and height	-	-	0	If brushes are worn out in height to 18 mm, replace them w new ones. Grind new brushes against commutator with glass paper, for which purpose run generator for 2-3 hours at 30-5 load
65. Perform the following checks:				
(a) Check generator terminal bolts for reliable tightening	-	-	0	Tighten up bolts, if necessary
(b) Check generator cooling air duct cap and air cleaner hoses for secure attachment	-	-	0	Tighten up loose joints

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1	2	3	4	5
(c) See that cap with air supply branch pipe is securely fastened to generator frame plate	-	-	0	Tighten up joint, if necess
(d) Make sure that generator shield is not loose	-	-	0	Fasten shield reliably
66. Examine starter terminals and contacts to which wire lugs are connected	-	-	0	Contacts and terminals must be clean and securely fastened. On detection of corrosion, clean contacts and tighten them up.
67. Check tension of engine protection valve cables	-	-	0	Perform operation as pointed out in Subsection 6.9.3.
68. Check engine protection valves for normal functioning	-	0	0	Set valves in operating position and secure handle 5 (Fig.15) in clips. With engine running, close switch 23 FLOATING (Fig.246). After the engine stops, signal lamp 39 VALVE must light up. Open switch FLOATING and put valves in ready-for-action position by displacing handle 5 (Fig.15) downward
69. Check preheater reduction gear for normal functioning	0	0	0	Perform check if reduction gear operation proves to be abnormal. Do it simultaneously with scheduled preventive maintenance. To perform the check, start and

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1	2	3	4	5
74. Check device TBHO-2 for reliable functioning and see that light beams of headlights	0	0	0	Perform operation before nig run. While performing check in da time—put on diaphragm

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1	2	3	4	5
88. Clean air filter of compressor	-	-	0	Remove filter 11 (Fig.309) secured on engine compartment bulkhead and clean it, as pointed out in Subsection 15.3.4
89. Check air cleaner water drain valve 11 (Fig.168) for reliable operation	-	0	0	Open access hole 21 (Fig.15) in engine compartment bulkhead and make sure that with handle 9 (Fig.6) shifted to position IN WATER (ВХОД В ВОДУ), pneumatic cylinder rod 9 (Fig.167) is drawn out, and when shifted to position LAND (СУША), drawn in
90. Lubricate pedal bridge (14)	-	-	0	Unscrew plug 22 (Fig.165) of filling hole and pack solid oil "C" till it comes from under pipe bushings
91. See that air intake shutter handle 16 (Fig.168) is reliably locked	0	0	0	Open access hole 9 (Fig.15) and make sure that in summer season shutter is closed, and handle is locked with wire
92. Check position of handles of mirror, blind and diaphragm of device ТКН-3Б	0	0	0	Mirror handle 8 (Fig.116) must be in DAY (Д) position, blind handle 19 and diaphragm handle 5 must be in CLOSED (ЗАКР.) position.
93. Check night branch of device ТКН-3Б for normal functioning	-	0	0	Perform check in dark time, with blind and diaphragm closed. Greenish glowing should be observed in the field of vision
Fighting Compartment				
94. Check all sight controls for normal functioning in day and night modes of operation	0	0	0	Perform check as pointed out in Subsection 5.2.7. The check over, set controls in initial position
95. See that nut on sight supply cable connector is reliably tightened	-	-	0	The nut must be tightened reliably
96. Check external assemblies for reliable attachment on sight body	-	0	0	If necessary, tighten up bolts and secure loose connections
97. Check optical axes of day and night branches of sight for matching	-	0	0	Perform check as pointed out in Subsection 5.2.8
98. Check gun and sight for mutual adjustment	-	0	0	Perform check, as pointed out in Subsection 5.2.9
99. Replace aviation cartridge with one taken from SPTA set	-	-	0	Recondition cartridge, as pointed out in Subsection 5.2.7
100. Make sure that gun-to-sight angles are accurately transmitted	-	-	0	Perform check, as pointed out in Subsection 5.2.9

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1	2	3	4	5
101. Check clearances between thrust screws and boss on housing of sight elevation adjustment mechanism 21 (Fig.97)	-	-	0	Clearance should not be less than 0.5 mm, with gun in extreme positions. To perform check, elevate gun and depress to maximum angles and measure clearance by feeler gauge
102. Inspect gun 2A28				Each time before firing inspect gun as pointed out in Subsection 3.2.6
103. Clean and lubricate gun 2A28				Each time after firing clean and lubricate gun, as pointed out in Subsection 3.2.5
104. Clean and lubricate machine gun				Clean and lubricate machine gun after firing, as pointed out in Subsection 3.3.4
105. Replace gun				Have gun replaced in workshop after it has fired 500 rounds. After gun has fired 500 rounds, it should not be used
106. Clean race and seats of conveyer	-	0	0	Clean with waste, moving the conveyer manually
107. Clean bands of loading mechanism rammer	-	0	0	Perform operation, as pointed out in Subsection 3.2.5
108. Check conveyer chain tension and adjust, if necessary				Perform check as pointed out in Subsection 3.2.5
109. Make sure that conveyer properly brings round to catching position				Perform check as pointed out in Subsection 3.2.5
110. Check feed mechanism and rammer securing bolts and other fastening parts of loading mechanism for secure attachment	-	0	0	If necessary, tighten up
111. Check clearance "y" (Fig.44)	-	0	0	Clearance must be within 0.5-0.8 mm. If necessary, adjust clearance by nuts 42 which are fixed with locknuts 43
112. Check clearances "F" and "G" (Fig.48). See that trough-catch pawls can be easily closed and opened	-	-	0	Proceed as pointed out in Subsection 3.2.5
113. Check loading mechanism for normal functioning	-	0	0	Perform check in semi-automatic duty by loading the gun for two-three times and bringing it to loading angle by means of drive 1ЭЦ10М (see Subsection 3.2.4)
114. Check guide rail for condition	-	0	0	Clean guide rail slides 3 (Fig.6 and remove scores and nicks.

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1	2	3	4	5
				Check bodies of missile connectors 23 and plug connector 31 for displacement relative to guide rail. Retainers 9, 18 and 37 should move freely. When push rod 21 is depressed or released, click should be heard
115. Check starting bracket for condition	-	0	0	Clean bracket. When shock absorber and retainer 12 (Fig.66) are depressed, springs 2 should be compressed, and when the former are released, the latter should expand. Plug of plug connector 11 should freely move along frame
116. See that guide rails are reliably joined with bracket	-	0	0	Guide rail should be easily rammed and reliably locked
117. Check starting circuits of control equipment 9C428 for serviceability	-	0	0	Perform check as pointed out in Subsection 3.5.11
118. Check clearance "V" (Fig.68) of ATGM	-	0	0	Proceed, as pointed out in Subsection 3.5.10
119. Check control equipment 9C428	-	0	0	Have the check performed by specialists of maintenance and test station at least once a year in compliance with Instructions on operation and use of group set of ground control equipment
120. Make sure that electric drive 1ЭЦ10М smoothly changes the rates of gun elevation and training	-	0	0	To perform the check, traverse turret in both directions and elevate and depress gun at minimum to maximum rates of laying. Jerks and delays are not allowed. Perform the check with engine running (beyond danger zone). Simultaneously, check limit switches for reliable functioning
121. Check operation of electric drive in zone of spotlight ОУ-3Г	-	0	0	When barrel approaches spotlight from right and left, traversing drive should be disengaged. When gun is over spotlight, elevation drive should be disengaged CAUTION: It is strictly forbidden to check danger zone clearance with vehicle hatches open
122. Replenish ammunition stock	0	0	0	Check and replenish ammunition stock in compliance with directions

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1	2	3	4	5
		Troop Compartment		
123. Remove dust from control equipment	-	0	0	Use brush
124. Check storage batteries for condition and state of charge	0	0	0	Mains voltage measured by voltammeter, with engine cranked by starter without fuel supply, must not be less than 17 V. If voltammeter indicates less than 17 V, boost-charge batteries. In cold seasons check batteries immediately upon return to park
125. Remove dust and dirt from locating places of ball supports, wipe them dry and coat (in winter) with thin layer of grease	0	0	0	Clean and lubricate ball supports, if they are dirty. For cleaning and lubricating procedure, see Subsection 3.7.3
126. Check amount of lubricant in reduction gear case of water drainage pump	-	-	0	Add grease ЦИАТИМ-201 up to driving shaft axis every 8000-10,000 km of run simultaneously with scheduled preventive maintenance

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17. VEHICLE STORAGE

17.1. GENERAL

For preparation of the vehicle for short-term and long-term storage, for in-storage maintenance and removal from storage, see "Armoured Vehicle Storage Manual".

Besides, observe the requirements of the present Section. During short-term or long-term storage the vehicle is kept filled and equipped, all the detachable standard articles are arranged on their places or stowed in standard packing.

The ammunition may be stored in vehicles, provided a special permission is given.

17.2. PREPARING THE VEHICLE FOR STORAGE

17.2.1. General

It is recommended to time preparation of the vehicle for storage with preventive maintenance No.2.

Preparation of the vehicle for storage includes preparation of the hull, turret, units and systems of the vehicle for short-term or long-term storage.

Preparation operations and preventive maintenance operations should be combined, if possible.

The rules of preparation of the units and mechanisms for storage set forth in the present Subsection must be observed both while preparing the vehicle for short-term and long-term storage.

17.2.2. Preparing the Hull,' Turret and Seats for Storage

While placing the vehicle in storage, do the following:

- tightly close all the outer hatches, doors, covers, ejector shutters and louvres;
- close the grill over the water radiator and oil cooler and the exhaust hole of the ejector with canvas mats;
- fix the troopers', commander's and driver's seats in the uppermost position;
- close the engine protection valves.

17.2.3. Preparing the Engine and Its Systems for Storage

Make sure that the valves designed to drain the coolant from the cooling system and the water from the ejector function reliably. If they bind, disassemble them, clean from corrosion, lubricate with oil MT-16п, assemble and reinstall.

When placing the vehicle in long-term storage and when sluching the engine in autumn, fill the cooling system with low-freezing liquid.

In addition, wash the engine cylinder liners as follows. Warm up the engine by the preheater until the coolant temperature reaches 80 - 90°C (irrespective of the ambient air

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temperature). Then start the engine and run it at a speed within 800 - 1000 rpm until the oil temperature reaches +30°C. After that, change over to 1500 - 1800 rpm and bring the coolant temperature to 70 - 75°C and oil temperature to at least+65°C. At the end of the warm-up establish the minimum speed and run the engine at this speed for 3 - 5 min and then shut down the engine by cutting off the fuel supply.

To prolong the engine service life, close the engine with mats and shut down the shutters.

To remove the corrosion and aggressive combustion products from the cylinders, wash the cylinders by feeding heated oil fog to the latter and cranking the engine simultaneously.

Wash the cylinders by means of set АКД-1. The set consists of an oil tank, pump МЗН-2, timer, control panel, hose and cables. The timer ensures switching on and off the starter and pump МЗН-2, delivering oil into engine cylinders, in a strict order.

The unit is connected to the vehicle mains as shown in Fig.330.

Cable 9 terminates in a box accommodating current limiter 8. The limiter serves to automatically switch off pump МЗН-2 when the crankshaft slows down because of high resistance.

Dispensing hose 12 is connected to the pipe union located on top of the cylinder block-and-crankcase unit on the flywheel side. On vehicles where this pipe union is not provided, connect the hose to the pipe union of the air distributor instead of the pipeline used to supply compressed air during engine start.

Wash the cylinder liners as follows:

- connect the dispensing hose of set АКД-1 to the air distributor and the electric wires, to the vehicle mains, as shown in Fig.330;
- fill the tank of set АКД-1 with 10 - 12 l of dehydrated oil heated to 80 - 90°C;
- start set АКД-1 and wash the cylinders; during operation watch the oil consumption and the order in which the signal lamps come on and go out.

Start set АКД-1 as follows:

- place switches TIMER (АВТОМАТ) and STARTER (СТАРТЕР) in the ON (ВКЛ.) position, and switch SLUSHING (КОНСЕРВАЦИЯ) in the ENGINE (ДВИГАТЕЛЬ) position;
- push button 14 (Fig.331) TIMER START (ПУСК АВТОМАТА) and keep it depressed for 2 - 3 s till the first click is heard in the timer; as soon as the button is depressed, white lamp 15 lights up and glows throughout the entire period of operation of timer 13.

Starter 5 is switched on automatically two or three seconds after the timer starts, and simultaneously red lamp 10 comes on; 0.5 s later, oil priming pump 6 starts and green lamp 9 lights up. Four seconds later, pump МЗН-2 stops (the green lamp goes out) and 0.5 s after that the starter stops (the red lamp goes out).

Then, the timer puts the starter and pump out of operation for 15 - 18 s, and after that the set operation is automatically repeated two times more.

For the fourth time after a pause of 15 - 18 s, the timer switches on only the starter for 5 s, so as to crank the engine, with the cylinders not supplied with oil. After that electric motor 12 of the control panel stops and the white lamp goes out.

The amount of oil pumped into the cylinders must be within 1.3 - 1.6 l. Check the amount of oil by glass gauge 15 (Fig.330) of the set tank.

If the oil consumption is less than required, repeat the cycle.

Switch on the set again after a 2 - 3 min interval.

If set АКД-1 is not available, wash the cylinders by means of a metering device (Fig.332).

The device consists of reservoir 1, manual oil priming pump 2, 150-cm^3 metering cylinder 4, pipe 3, metering cylinder rod 6, locking screw 8, and oil priming hose 5.

For washing the cylinders, connect hose 5 to the pipe union of the air distributor and open access hole cover 29 (Fig.8) on the engine clutch housing, and then do the following:

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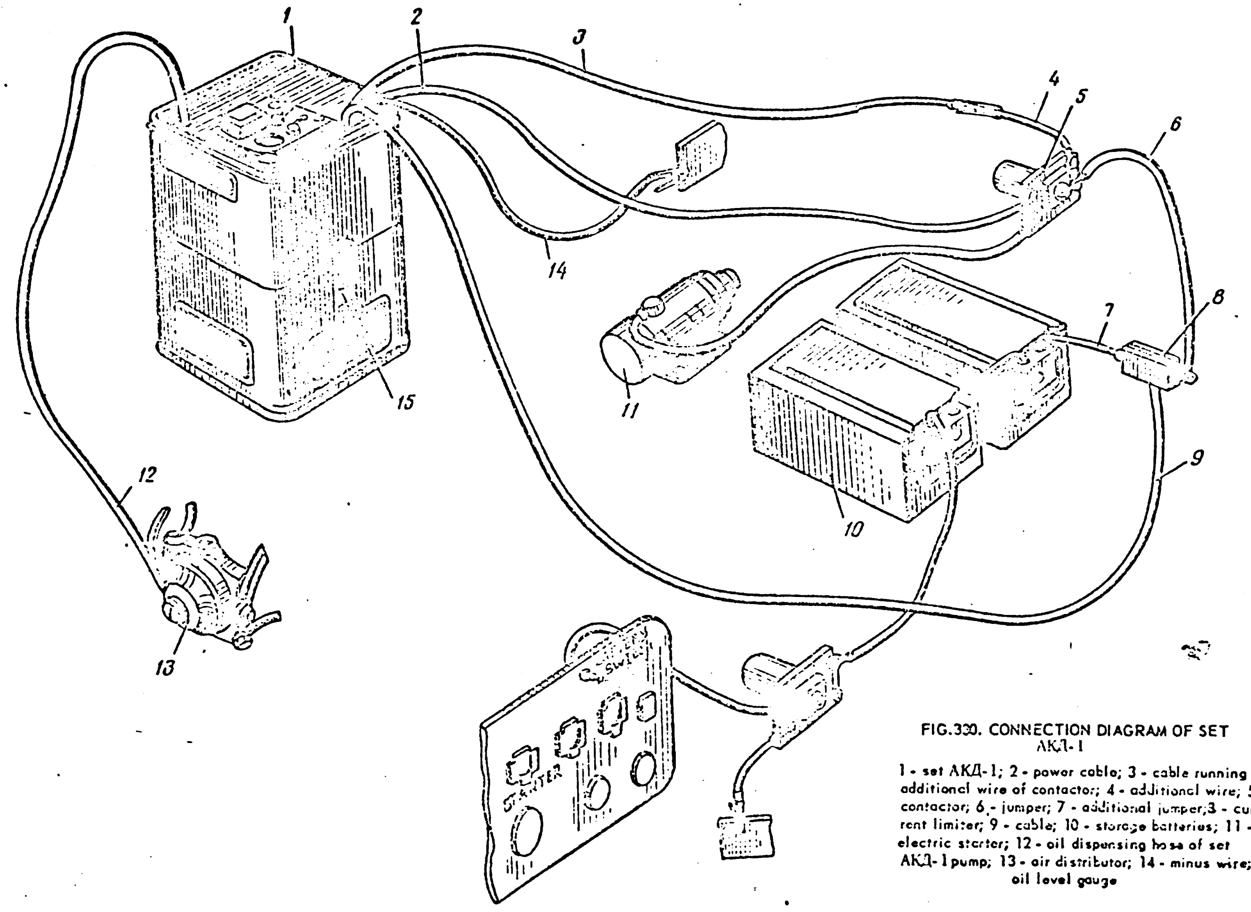
1
2
3
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9
10
11
12
13
14
15
STARTER
SWITCH

FIG.330. CONNECTION DIAGRAM OF SET
АКД-1

1 - set АКД-1; 2 - power cable; 3 - cable running to additional wire of contactor; 4 - additional wire; 5 - contactor; 6 - jumper; 7 - additional jumper; 3 - current limiter; 9 - cable; 10 - storage batteries; 11 - electric starter; 12 - oil dispensing hose of set АКД-1 pump; 13 - air distributor; 14 - minus wire; 15 - oil level gauge

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- using the index, set the flywheel to 24°±2° before the TDC;
- using manual pump 2 (Fig.332), prime each cylinder with 160 - 180 cm^3 of oil, when priming the cylinders for the first time, pump 100 cm^3 of oil more to fill up the air distributor cap;
- each time upon priming the cylinders, turn the crankshaft by 120° forward;
- after the cylinders are washed for the first time, turn the crankshaft by one or two revolutions without oil supply and then prime each cylinder with 160 - 180 cm^3 of oil again by the same method;
- remove surplus lubricant from the cylinders by turning the crankshaft through four or five revolutions forward;
- if flywheel turns with difficulty, turn it by one or two revolutions in the opposite direction and then by four or five revolutions forward;
- on disconnecting oil priming hose 5, secure the air pipeline to the air distributor, drain the lubricant from the intake manifolds of the engine through drain plugs 14 (Fig.135).

CAUTION: Turn the crankshaft manually by means of the cranking device.

While washing the engine cylinders, observe the following requirements:

- the temperature of the coolant in the cooling system and temperature of the oil in set АКД-1 must not be below +60°C throughout the entire period of washout, in the cooling system the coolant temperature must be maintained at the required level by means of the preheater, and the cooled oil in set АКД-1 must be replaced with hot one;
- the storage batteries must be charged to 90 % minimum of the rated capacity.

To prepare the speed governor for storage, proceed as follows:

- unscrew the dipstick from the governor housing;
- take adapter No.1 from the ЗРТА set of set АКД-1, insert it in the governor housing and connect the suction hose of the piston pump of set АКД-1;
- scavenge all the oil from the governor housing;
- insert a funnel having a fine gauze in the hole for the dipstick and fill the governor housing with dehydrated oil МТ-16п heated to 60 - 90°C;
- shift outer control lever 43 (Fig.156) three or four times from the STOP (СТОП) position to the maximum feed screw;
- insert adapter No.3 in the hole for the dipstick, connect the suction hose of the piston pump of set АКД-1 to the adapter and scavenge surplus oil from the governor housing;
- check the oil level in the governor and then put the dipstick in its place.

While preparing the fuel system, which was filled with fuel Т-1 or ТС-1, drain it and fill the system with diesel fuel. To remove remaining fuel Т-1 or ТС-1, run the engine for 10 min.

17.2.4. Preparing the Water-Drainage Facilities

Check the front and rear water-drainage pumps for functioning and the water discharge valves for condition.

Disassemble the valves, clean them of dirt and corrosion. Restore the damaged paint coat and lubricate the unpainted surfaces with grease ГОИ-54п.

Assemble and reinstall the valves.

Clean the pump screens from dust and corrosion.

17.2.5. Preparing the Running Gear

While preparing the vehicle for storage, coat the track shoes with enamel МС-17 or

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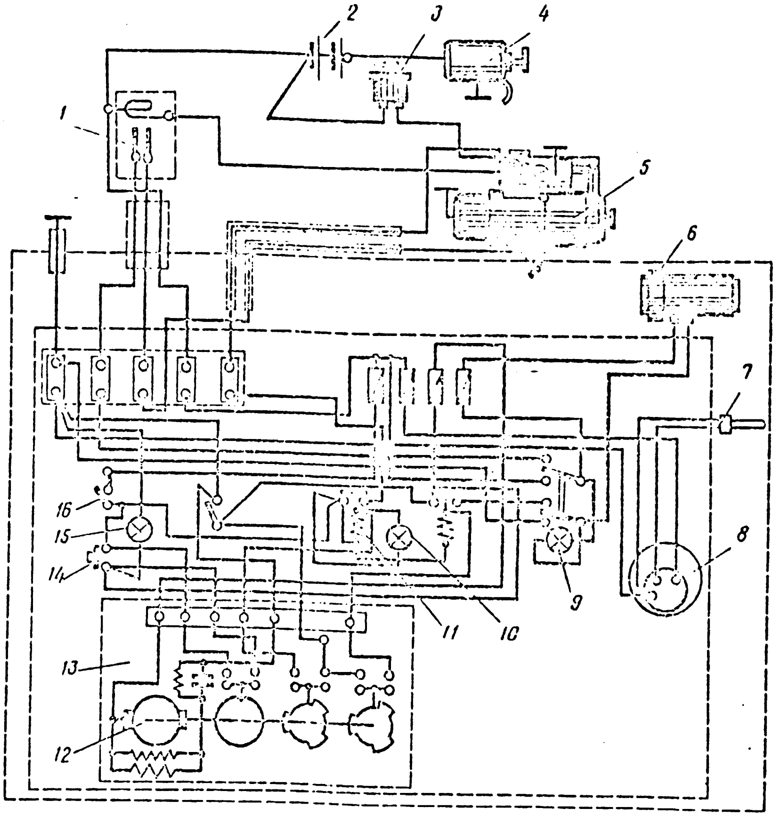

FIG.331. ELECTRIC CIRCUIT DIAGRAM OF SET AKД-1

1 - current limiter; 2 - storage batteries; 3 - starter button; 4 - battery switch; 5 - electric starter; 6 - oil priming pump; 7 - sending unit of temperature gauge; 8 - indicator of temperature gauge; 9 - green lamp; 10 - red lamp; 11 - contactor; 12 - electric motor of set; 13 - timer; 14 - button TIMER START; 15 - white lamp; 16 - protection unit change-over switch

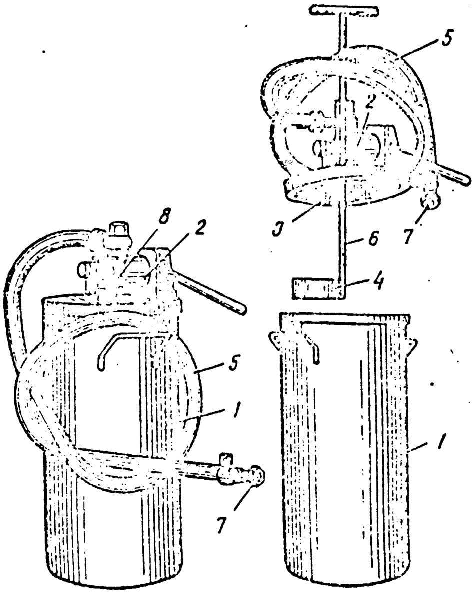

FIG.332. METERING DEVICE (ПЗМ) FOR FILLING OIL INTO ENGINE CYLINDERS

1 - oil reservoir; 2 - manual oil priming pump; 3 - oil intake pipe; 4 - metering cylinder, 150 cm^3 capacity; 5 - oil priming hose; 6 - metering cylinder rod; 7 - nipple for connection to air distributor; 8 - locking screw

[redacted]

17.2.6. Preparing the Armament

Clean all the parts of the loading mechanism from dirt, dust and corrosion.

Restore the damaged paint coat, and coat the unpainted surfaces with a thin layer of grease ГОИ-54п.

Fix the levers of the loading mechanism in an intermediate position.

Close the trough-catch pawls (if the dummy is in the seat of the conveyer on the feed line, remove it and put on the stowage place).

Clean the glasses of the ball supports, and coat the ball supports of the submachine guns and machine guns with grease ГОИ-54п or mixture of oil МТ-16п (50%) and solid oil (50%).

17.2.7. Preparing the Air-and-Liquid Cleaning System of Vision Devices

If the tank is filled with water, drain it and fill the tank with low-freezing liquid, grade "40" or "65". Then, press button CLEANING (ОЧИСТКА) on the driver's central panel for one or two seconds. If the system functions normally, replenish the tank and screw in the plug.

17.2.8. Preparing the Sight

Perform preventive maintenance No.2.

Fit a light-proof paper cap on the eyepiece.

Make sure that the blind control handle is in position CLOSED (ЗАКРЫТО) and inscription НС-12 is seen on the facet of the light filter change-over knob.

17.2.9. Preparing Radio Station Р-123М

Release drum locks 1, 2, 3, and 4, for which purpose open cover 22 (Fig.278), and turn the locks with the help of a screwdriver. Set the fixed frequency selector 21 in position CONTINUOUS BAND ("I" or "II") so as to release springs tension and thus to elongate the service life of the springs.

17.3. IN-STORAGE MAINTENANCE OF VEHICLE

During long-term and short-term storage keep the fuel and lubricating systems filled to capacity the year round. When the vehicle is placed in short-term storage, the fuel system must be filled with summer diesel fuel in warm seasons, and with winter or arctic fuel in cold seasons.

While preparing the vehicle for summer operation, the winter diesel fuel may be left in the system. It is recommended to replace arctic fuel.

When the vehicle is placed in short-term storage, with the hull sealed or not sealed, keep the cooling system filled with boiled water containing a three-component additive in summer, and with low-freezing liquid, in winter.

When the vehicle is placed in long-term storage, keep the cooling system filled with low-freezing liquid in all the seasons.

If the vehicle is not sealed, put device ТКН-3Б in operation for at least 30 min, once every six months. Energize the devices only from the vehicle mains or from the storage batteries having a sufficient capacity.

For long-term storage of devices ТВНО-2 and ТКН-3Б, preserve them, and depreserve after one year (device ТКН-3Б) or two years (device ТВНО-2), during depreservation wipe all the greased parts with a piece of clean cloth slightly soaked in aviation gasoline, dry and coat with a thin layer of gun grease or grease УН.

CAUTION: While proceeding with preservation, protect the optical and rubber parts and the painted surfaces from gasoline and grease.

[redacted]

17.4. REMOVAL OF VEHICLE FROM STORAGE

While removing the vehicle from storage, do the following:

- unseal the vehicle and remove the silica gel;
- remove the slushing compound;
- remove the previously installed plugs;
- install the charged storage batteries and other equipment if they were removed before storage;
- make sure that the fuel and lubricating systems are filled to capacity with fuel and lubricants corresponding to the season;
- check the pipelines, hoses and joints for secure connection;
- see that the cylinders of the fire-fighting equipment and pneumatic system are charged to capacity;
- check the circuits of the fire-fighting equipment for serviceability;
- check the tension of the tracks;
- check the tension of the compressor drive belts and adjust it if necessary;
- start the engine and check:
  (a) the engine for normal functioning;
  (b) the instruments for correct readings;
  (c) the connections for leakage;
- check the illuminating and signalling devices;
- check the communication facilities for serviceability;
- depreserve the armament;
- check the amount of fluid in the hydraulic recoil mechanism;
- check the loading mechanism, laying drives, sight and anti-tank guided missile launcher;
- check to see that the SPTA set is complete and in good condition.

[redacted]

[redacted]

Appendix 1

VEHICLE SEALING

For sealing the vehicle, it is necessary to close all holes and slits in the vehicle hull and turret by glueing moisture proof material (cloth TT or paper ПБ) and by applying special putty 33K.

Besides, it is necessary to put desiccant (silica gel) inside the vehicle.

The sealing diagram is given in Fig.334.

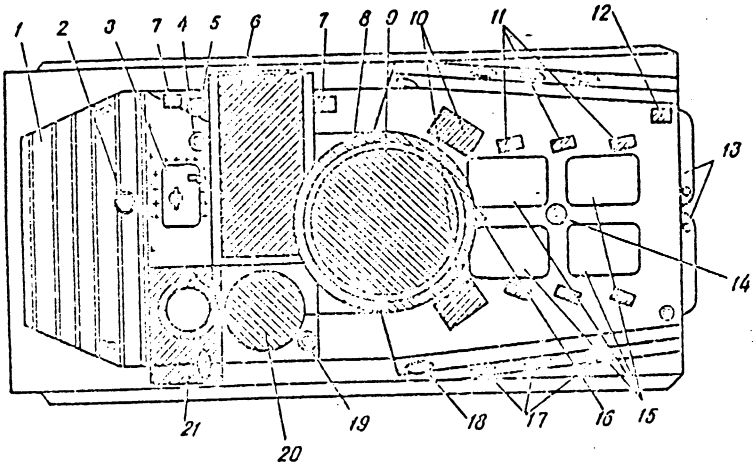

FIG.334. VEHICLE SEALING DIAGRAM

1 - front ribbed plate; 2 - plug of power transmission oil filler hole; 3 - above-engine access hatch cover; 4 - cooling system filler plug; 5 - oil tank filler plug; 6 - ejector louvres and shutters (closed with one piece of cloth TT); 7 - visors over water discharge holes for front and middle water drainage pumps; 8 - turret race ring; 9 - turret roof; 10 - outlet ports for exhaust blowers; 11 - troopers' vision devices; 12 - water discharge hole for rear water drainage pump; 13 - rear doors; 14 - main fuel tank filler plug; 15 - troop compartment hatches; 16 - air intake pipe; 17 - firing ports for submachine guns; 18 - firing port for machine gun; 19 - access hole; 20 - commander's hatch; 21 - driver's hatch

VEHICLE SEALING PROCEDURE

To be sealed	Expenditure of sealing cloth (paper)		Instructions on sealing
	size of pieces, cm	number of pieces	
1	2	3	4
1. Turret roof	Circle, dia.140	1	Make circle of two glued overlapped pieces of cloth. Lay cardboard or solid paper under cloth on sharp edges
2. Turret race ring	500x15	1	-
3. Gun shield	205x60	1	Start sealing the shield from lower part

[redacted]

[redacted]

1	2	3	4
4. Muzzle face	30x10	1	Lavishly coat muzzle face with grease ГОИ-54п and wrap in parchment paper
5. Front ribbed plate of hull and engine roof plate (edges and gearbox oil filling plug, engine access hatch and coolant and oil filling plugs)	-	-	Seal with putty. If gaskets are sound, indicated points need not be sealed with putty
6. Louvres over water radiator and oil cooler and ejector diffuser	180x140	1	Seal louvres and diffuser with two overlapped glued pieces of cloth, 75x180 cm
7. Driver's hatch, driver's vision devices	125x75	1	-
8. Commander's cupola	Circle, dia. 75	1	-
9. Air intake pipe	Circle, dia. 40	1	-
10. Machine gunners' vision devices, exhaust blower ports and marker lights	45x45	2	-
11. Vision devices on roof and doors	35x25	8	-
12. Holes in troop compartment to discharge water by water drainage pumps	20x20	3	-
13. Stop light	20x20	1	-
14. Firing ports and marker lights	-		Seal with putty
15. Hull bottom (covers of access holes under engine, coolant drain plug, fuel tank drain plug, oil tank drain plug, engine crankcase drain plug, plug to drain water from ejector casing, plug to drain water from vehicle hull, preheater exhaust hole cover, plug to drain oil and water from gear case)	20x20 15x15	1 1	Seal with putty If gaskets are sound, access hole covers and plugs need not be sealed with putty
16. Access holes in engine compartment bulkhead	-	-	While sealing the vehicle, open access holes
17. Rear doors of troop compartment	-	-	Close and dog down doors in same manner as when preparing the vehicle for crossing water obstacle
18. Vehicle inner space	-	-	Load 30 kg of silica gel through upper hatches of troop compartment and hang bag with silica gel indicator in hole for one of above engine access hatch bolts. Arrange silica gel in fighting and troop compartments

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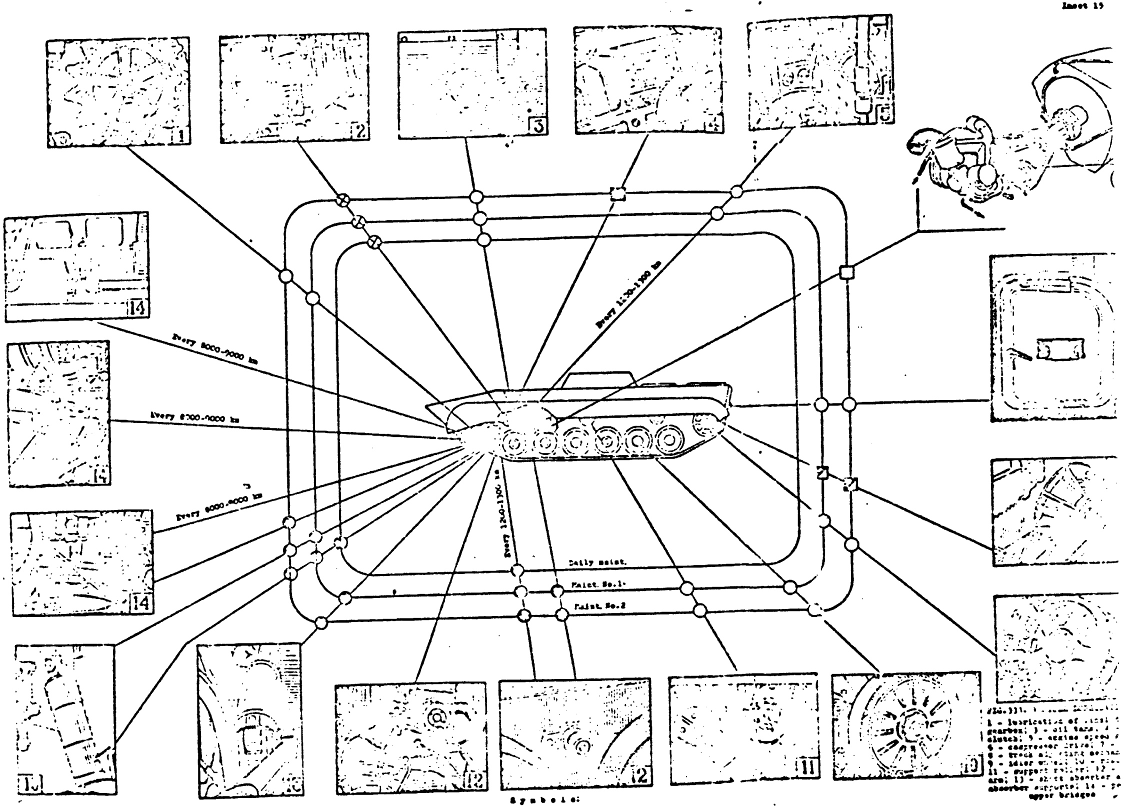
Inset 19



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Every 8000-9000 km
Every 8000-9000 km
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Every 1200-1300 km
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Maint. No.1
Maint. No.2
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Fig. 331. [illegible]

1 - lubrication of [illegible] gearbox; 3 - oil tank; 4 - [illegible] clutch; 5 - engine speed [illegible] 6 - compressor drive; 7 - [illegible] 8 - track [illegible] 9 - idler wheel; 10 - [illegible] 11 - support roller; 12 - [illegible] arm; 13 - shock absorber [illegible] absorber supports; 14 - [illegible] upper bridges

Symbols:

⊗ — Oil MT-8B

○ — Oil MT-16P

◐ — Mixture of transformer oil (50%) and turbine oil (50%)

○ — Solid oil C (automotive lubricant PCs)

◄━ ━ Checking of lubrication

☒ — Grease ZIATSIY-200

▣ — Grease PF-1

☐ — Grease ZIATIM-201

[redacted]

[redacted]

1	2	3	4
19. Hatches of troop compartment	-	-	Seal with putty. If gaskets are sound, hatches need not be sealed with putty
20. Headlights	100x60	2	Place bag with silica gel (400 g) beside headlight under sealing cloth
21. Boxes with SPTA set			Place one bag with silica gel in each box and seal box covers with putty

Note. Attach cloth TT to metal surfaces with glue KT, and coat the edges of the cloth with putty 33X-3У.

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Appendix 2

SPARE PARTS, TOOLS AND ACCESSORIES

The carried-on SPTA set (Fig.335) includes spare parts, tools and accessories designed for fulfilment of the maintenance operations and for elimination of minor faults by the crew.

The SPTA set is arranged outside and inside the vehicle.

Ref. No. in Fig.	Description	Qnty,pcs	Place of stowage
	SPTA Arranged Outside the Vehicle (Fig.336)		
1	Canvas cover to be put on the vehicle at halts and during transportation by railway	1	On turret rear
2	Towing wire rope	2	On troop compartment roof
3	Spade	1	On roof, to right of turret
4	Mat for closing the air intake ports	1	Together with canvas cover
5	Mat for closing the air intake ports	1	Together with canvas cover
6	Mat for ejector	1	Together with canvas cover
7	Self-recovery wire rope	2	On troop compartment roof
8	Track shoe	2	On right and left rear doors
9	Cover to protect launcher from dust and water	1	On launcher bracket
10	Rope to tie up canvas cover on vehicle	1	Together with canvas cover
	SPTA Arranged Inside the Vehicle (Fig.337)		
1	Bucket for manually filling the fuel, lubricating and cooling systems	1	Under right troopers' seat
2	Box for SPTA	1	On left side of fighting compartment floor
3	Box for SPTA set of gun 2A28 and buoy	1	On right side of fighting compartment floor
4	Portable fire extinguisher OУ-2	1	On left side of rear plate
5	Box for electric lamps and safety fuses	1	Under commander's seat in driving compartment
6	Cleaning rod (assy) for gun 2A28 (SPTA set for gun 2A28)	1	On right side of fighting compartment
7	Device for pulling off the tracks	2	On floor under left trooper's seat
8	Case for cleaning rod (SPTA set for gun 2A28)	1	On right side of fighting compartment
9	First-aid kit	1	On right side of fighting compartment
10	Filter for purification of water, fuel and oil	1	In bucket
11	Funnel for water, fuel and oil	1	In bucket
12	Cloth, 450x900, for filtration of fuel	1	In bucket
13	Tank for drinking water	1	On engine compartment bulkhead to right of commander's seat

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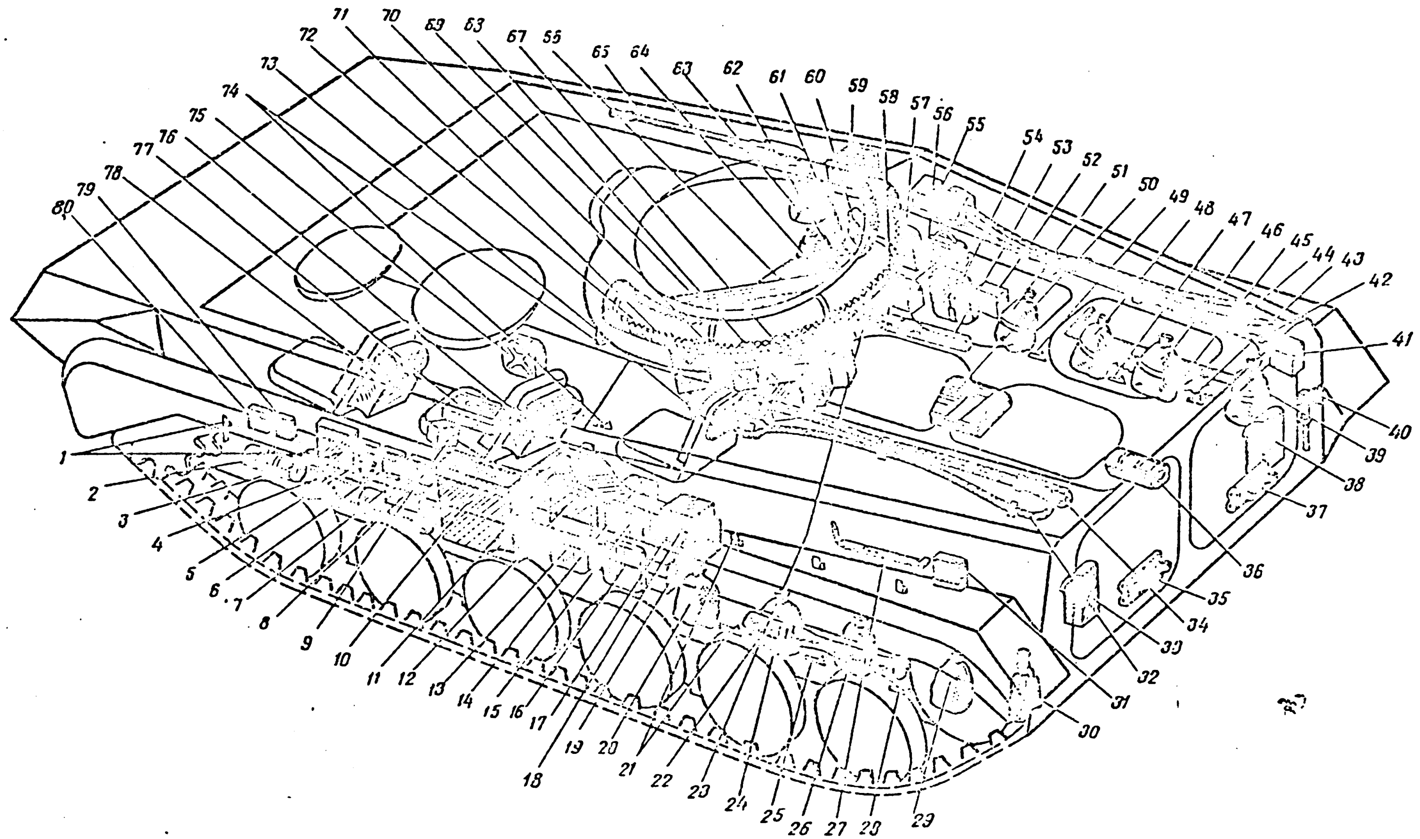

FIG.335. ARRANGEMENT OF SPTA SET IN VEHICLE

1 - driver's submachine gun stowage place; 2 - signal flags and bag with driver's tools;
3 - driver's gas mask; 4 - gas protection set; 5 - holster with flare pistol; 6, 7 - bags
with signal flares; 8 - bag with portable lamps; 9 - case with grenades Ф-1; 10 - driver's
protective hood and bag with documents; 11 - driver's sack; 12 - magazine with cartridges;
13 - magazine; 14 - case with grenades Ф-1; 15, 16, 54, 56, 57, 58 - magazines; 17 - light
anti-tank rocket launcher РПГ; 18 - РПГ projectiles; 19 - box with SPTA set for ТВНО-2,
ТКН-3Б, 1ПЗ22М1, 9М14М; 20 - trooper's sack; 21 - submachine gun stowage place; 22 -
trooper's sack; 23 - box for spare parts and tools; 24 - antenna; 25 - stowage place for
submachine gun AKM; 26 - trooper's sack; 27 - grease gun; 28 - stowage place for
submachine gun AKM; 29 - trooper's sack; 30 - fire extinguisher ОУ-2; 31 - bag with breast
switch of tank interphone system; 32 - towing wire rope; 33 - bag for headset; 34 - self-
recovery wire rope; 35 - spare track shoe; 36 - plunger-type grease gun; 37 - spare track
shoe; 38 - bag for headset; 39 - trooper's sack, 40 - axe; 41 - bag with breast switch, 42 -
self-recovery wire rope; 43 - stowage place for submachine gun AKM; 44 - towing wire
rope; 45 - saw; 46 - trooper's sack; 47 - stowage place for submachine; 48 - trooper's sack;
49 - stowage place for submachine gun AKM; 50 - bucket with funnel; 51 - trooper's sack;
52 - first aid kit; 53 - cleaning rod; 55 - boxes with foodstuffs; 59 - box for set А.Ік-1;
60 - box for bore-sighting gauge; 61 - dummy round; 62 - SPTA set for coaxial machine
gun; 63 - operator's sack; 64 - commander's sack; 65 - spade; 66 - SPTA set for gun; 67 -
bag for caps of missile connector and rammer covers; 68 - operator's gas mask; 69 -
empty case-and-link collector and magazines for machine gun ПКТ; 70 - bag with breast
switch; 71 - bag for headset; 72 - canvas cover with mats; 73 - pocket with extractor and
conveyer manual drive handle; 74 - stowage place for operator's submachine gun; 75 -
tank with drinking water; 76 - bag for headset; 77 - box with SPTA set for electrical
equipment; 78 - bag for headset; 79 - bag with breast switch; 80 - bag with breast switch

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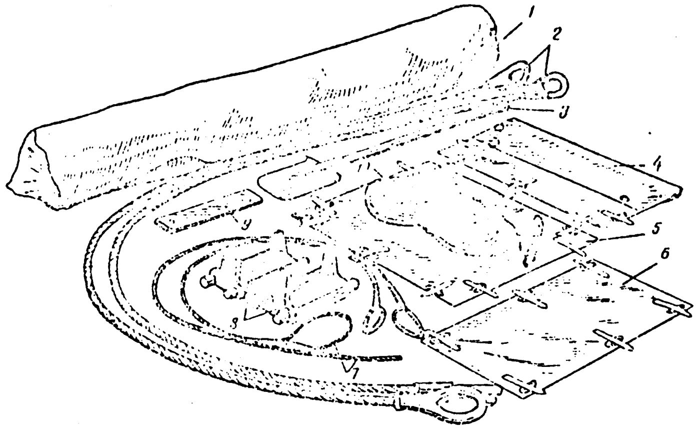

FIG. 336. SPTA ARRANGED OUTSIDE THE VEHICLE
(for designations see the table, appendix 2)

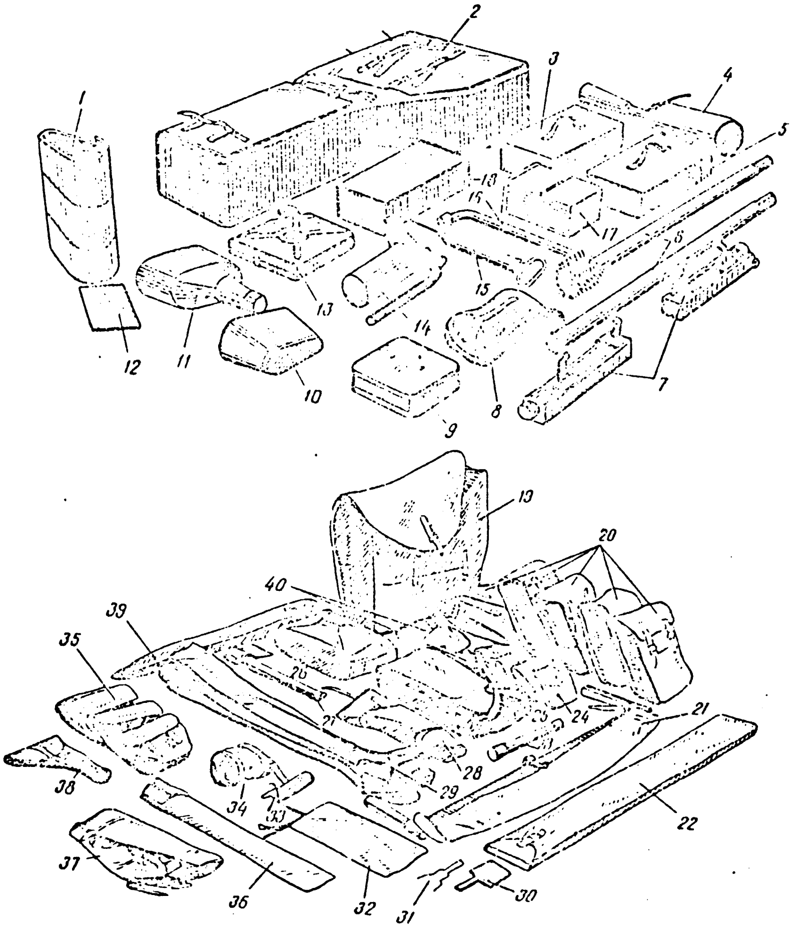

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FIG. 337. SPTA ARRANGED INSIDE THE VEHICLE
(for designations see the table, appendix 2)

[redacted]

[redacted]

Ref. No. in Fig.	Description	Qnty, pcs	Place of stowage
14	Plunger-type grease gun	1	Under right troopers' seat
15	Oil gun for filling the running gear with oil	1	Under left troopers' seat
16	Wrench S=22 for nuts and wedges of running gear	1	On floor under left troopers' seat
17	Box for foodstuffs	6	In right-side bay
18	Box for spare parts and tools	1	On floor of fighting compartment
19	Bag for driver's protective hood	1	On left side of fighting compartment
20	Bag for headset	5	1-on wall of ПКТ machine gun magazine; 1-on commander's seat back; 1-on right rear door; 1-on left rear door; 1-on driver's seat back
21	Case for saw	1	In troop compartment
22	Antenna in case	2	On left side of troop compartment
23	Rammer	1	Together with bag on ПКТ machine gun magazine
24	Bag for breast switch	5	3-on left side; 1-on right side; 1-on turret race ring
25	Bag for SPTA	1	On bulkhead in fighting compartment
26	Bag for documents	1	In bag for driver's protective hood
27	Axe	1	On right side of troop compartment
28	Bag for driver's tools	1	On left side of driving compartment together with case for flags
29	Cover for guide rail	4	On guide rail
30	Handle for manual drive of conveyor	1	In pocket on operator's seat back
31	Extractor for missile 9М14М	1	In pocket on operator's seat back
32	Bag for caps of plug connectors and cover of ПКТ machine gun	1	On ПКТ machine gun magazine
33	Cover for ПКТ machine gun barrel	1	In bag on ПКТ machine gun magazine
34	Cover for gun muzzle end	1	In box on left side of fighting compartment floor
35	Bag for grenades Ф-1	4	In cells of rotating floor
36	Case for flags	1	On left side of driving compartment

[redacted]

Ref. No. in Fig.	Description	Qnty, pcs	Place of storage
37	Case for SPTA set of ПКТ machine gun	1	On right side of bulk-head of engine compartment
38	Holster for signal pistol	1	On left side of fighting compartment
39	Dummy round ПГ-15В for gun	1	On right side of fighting compartment
40	Bag for flares	2	On left side of fighting compartment

Articles Contained in SPTA Box (Fig.338)

1	Wire rope for pulling on the tracks	1	
2	Spotlight ОУ-3Г	1	
3	Headlight ФГ-126	1	
4	Front frame for spotlight ОУ-3Г	1	
5	Bracket for setting ТВНО-2 device in travelling position	1	
6	Device ТВНО-2	1	
7	Device ТНП-350Б	1	
8	Box for SPTA set of devices ТВНО-2, ТКН-3Б, sight 1ПН22М1, missile 9М14М	1	
9	Box for SPTA	1	
10	Box with bore-sighting gauge	1	
11	Box for SPTA set of radio station Р-123М	1	
12	Wrench for access hole covers and plugs of gun trunnion wedges	1	Kept by crew member
13	Holder with heater for device ТВНО-2	1	
14	Cap with diaphragm for checking device ТВНО-2 in daytime	1	
15	Headrest of device ТВНО-2	1	Together with device
16	Device ТНПО-170	1	

Articles Contained in Box for SPTA Set of Devices ТВНО-2, ТКН-3Б, Sight 1ПН22М1 and Missile 9М14М (Fig.339)

1	Piece of flannel cloth for wiping the glass of device ТВНО-2	2	
2	Screwdriver for desiccators and aviation cartridges of sight 1ПН22М1	1	
3	Wrench S=5 (GOST 2841-54) for 1ПН22М1	1	
4	Tube	1	
5	Piece of flannel cloth 200x200 for wiping the glass of device ТКН-3Б	1	
6	1-A safety fuse for high-voltage power pack of device ТВНО-2	5	
7	Washer for device ТВНО-2	2	
8	Wrench 307 for device ТКН-3Б	1	
9	Eyeshield for device ТКН-3Б	2	
10	Eyepiece heater for device ТКН-3Б	1	

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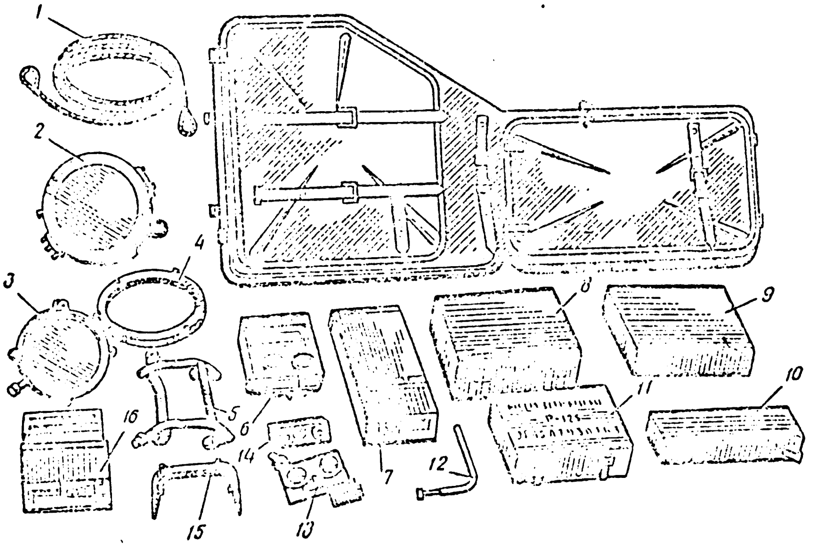
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FIG.338. ARTICLES CONTAINED IN SPTA BOX (for designations see the table, Appendix 2)

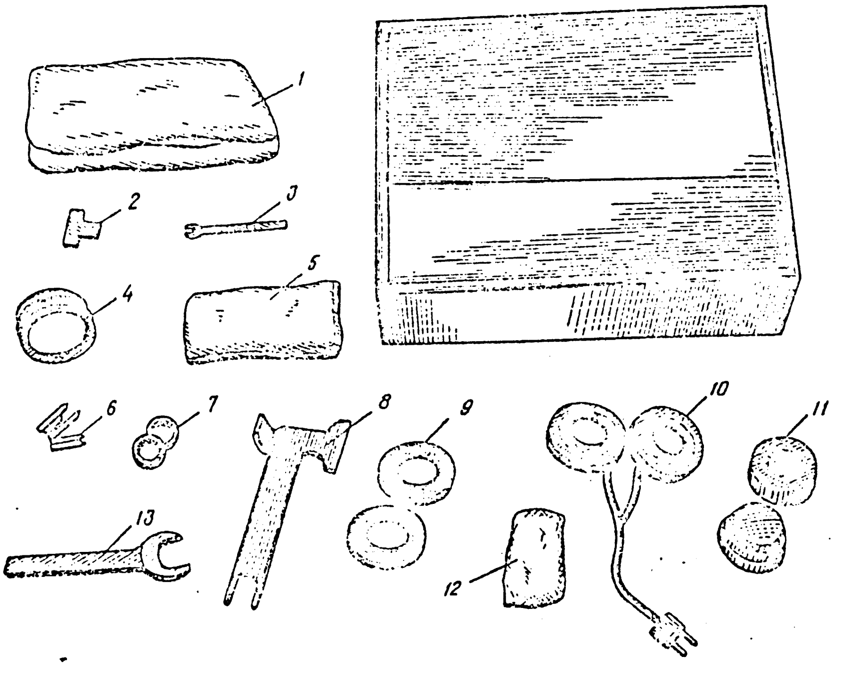
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FIG.339. ARTICLES CONTAINED IN SPTA BOX FOR TBHO-2, TKH-3Б, ПH22M1, 9M14M

[redacted]

Ref. No. in Fig.	Description	Qnty, pcs	Place of stowage
11	Desiccators in sleeve for device ТКН-3Б	2	-
12	Piece of flannel cloth for wiping the glass of sight 1ПН22М1	1	-
13	Wrench S=17 for missile 9М14М	1	-
	Ring	3	-
	Lamp СМ-37	4	-
	Screwdriver	1	-
	Cambric	1	-
	Forceps	1	-
	Safety fuses		
	Gaskets		
	Brushes		

Articles Contained in Box for SPTA Set of Radio Station Р-123М (Fig. 340)

Ref. No. in Fig.	Description	Qnty, pcs	Place of stowage
1	Valve ГУ-50	1	-
2	Holders for safety fuses		
3	Box with triodes	1	-
4	Multi-purpose screwdriver	1	-
5	Composite screwdriver	1	-
6	Throat microphone	1	-
7	PVC tube	0.5 m	-
8	Wire	3 m	-
9	Washer	6	-
10	Screw	6	-
11	Plug	1	-
12	Wrench for removing the neon lamp cap	2	-
13	Protective cap	4	-
14	Socket wrench	1	-
15	Wrench for adjustments	1	-
16	Wrench for fixing the drum discs	3	-

Articles Contained in Bore-Sighting Gauge Box (Fig. 341)

Ref. No. in Fig.	Description	Qnty, pcs	Place of stowage
1	Bore-sighting gauge	1	-
2	Flag	1	-
3	Cloth	1	-

Articles Contained in Box for Electric Lamps and Safety Fuses (Fig. 342)

Ref. No. in Fig.	Description	Qnty, pcs	Place of stowage
1	Filament lamp for headlights	5	-
2	Filament lamp	14	-
3	Filament lamp	13	10 - signal lamps; 2 - for sight 1ПН22М1; 1 - for launcher
4	Filament lamp for sight 1ПН22М1	6	One lamp inside illuminating unit

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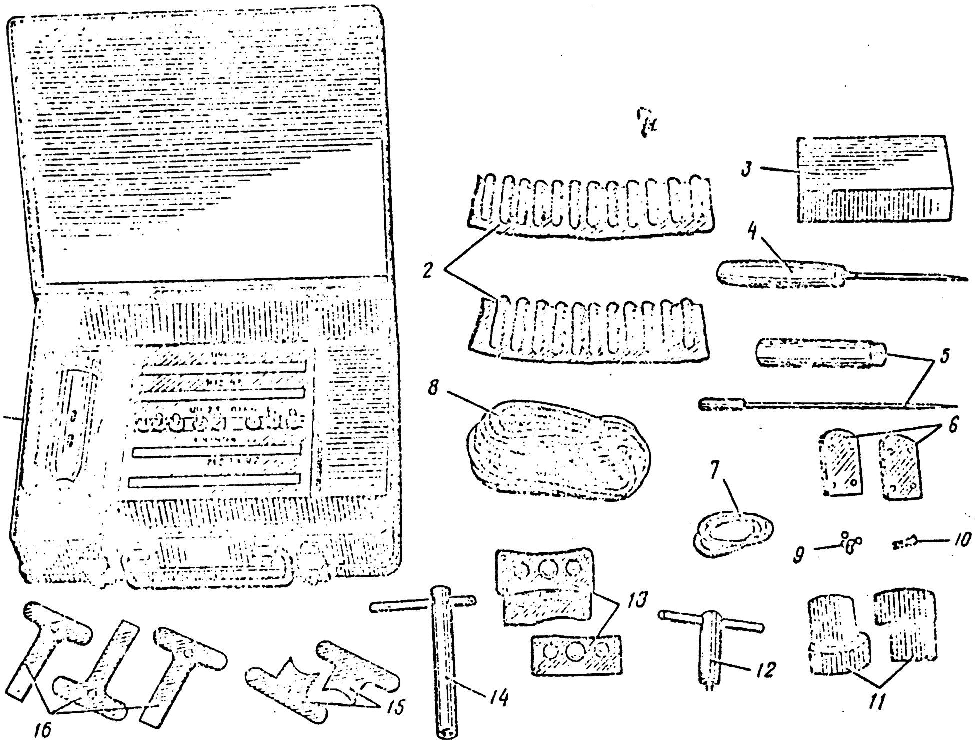
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FIG.340. ARTICLES CONTAINED IN BOX FOR RADIO STATION SPTA SET

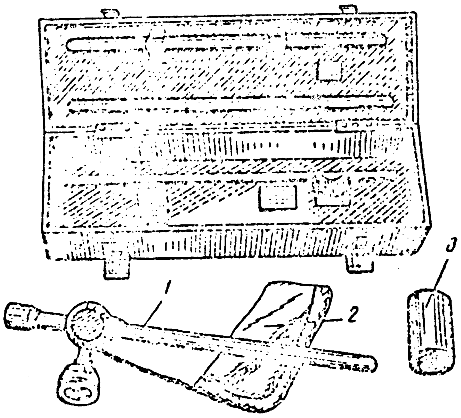

FIG.341. ARTICLES CONTAINED IN BOX FOR BORE-SIGHTING GAUGE

[redacted]

Ref. No. in Fig.	Description	Qnty, pcs	Place of stowage
5	Filament lamp for sight 1ПН22М1	6	One lamp inside illuminating unit
6	Filament lamp for spotlight ОУ-3Г	3	-
7	Fuse link for power board	4	-
8	Polarized relay РП-5 for drive 1ЭЦ10М	1	-
9	Fuse link ПЗ-250 for electric circuit of turret and battery	1	-
10	Special polarized relay for relay box КР-40	1	-
11	Fuse link for power board	2	-
12	Fuse link for power board	2	-
13	Fuse link for power board	2	-
14	Protector for relay boxes КР-45, КР-55, КР-60	13	-
15.	Protector for drive 1ЭЦ10М	4	-
16	Protector for relay box КР-45	2	-
	Safety fuse for electric circuit of loading mechanism, electric drive and lighting system	24	Safety fuses СП-10А - 20 pcs Safety fuses СП-5А - 4 pcs
	Safety fuse for device ТКН-3Б, spotlight ОУ-3Г, radio station Р-123М	3	-
	2-A safety fuse for control equipment	3	1-in device 9В329 2-in device 9В351
	5-A safety fuse for control equipment	6	-
	1-A safety fuse of sight 1ПН22М1	3	-

Articles Contained in Box for SPTA Set of Gun 2A28 and Buoy (Fig.343)

1	Bag for individual SPTA set	1	-
2	Wrench for screw	1	-
3	Brush with holder	1	-
4	Firing pin	1	In bag for individual SPTA set
5	Wrench for breechblock	1	-
6	Drift 2 (SPTA set for gun 2A28)	1	-
7	Diopter (SPTA set for gun 2A28)	1	-
8	Buoy	1	-

Articles Contained in Box for Spare Parts and Tools (Fig.344)

1	Feeler gauge to check engine clutch for adjustment	1	-
2	Ratchet wrench, S=27, for rotating the device for pulling together track shoes	1	-
3	Adapter to funnel for filling the transmission with oil	1	-
4	Box wrench, 27-32 mm, for track adjusting mechanism, for pulling off the track shackles, for tightening the power plant rear support securing bolts	1	-

[redacted]

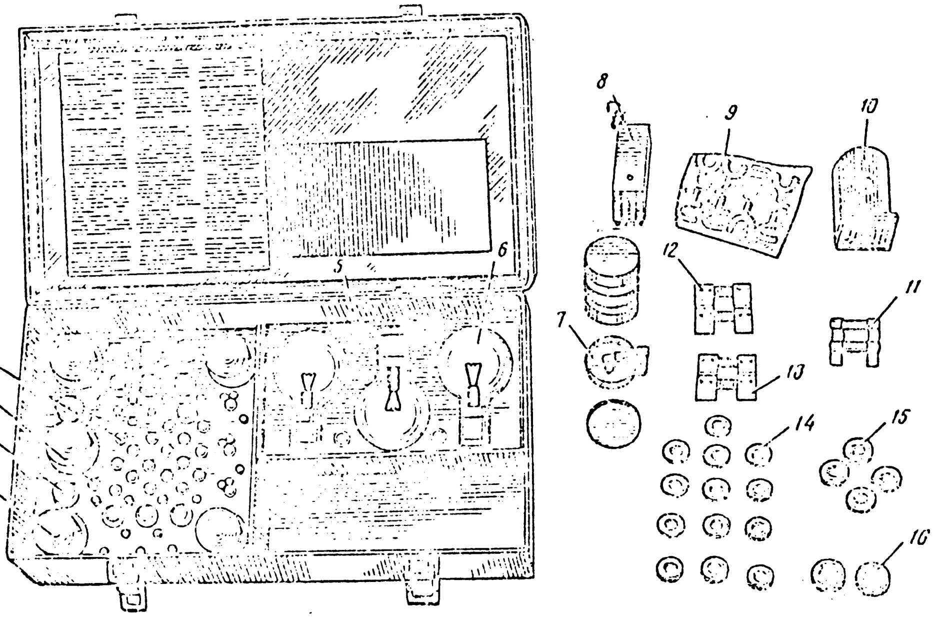

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FIG.342. ARTICLES CONTAINED IN BOX FOR ELECTRIC LAMPS AND SAFETY FUSES

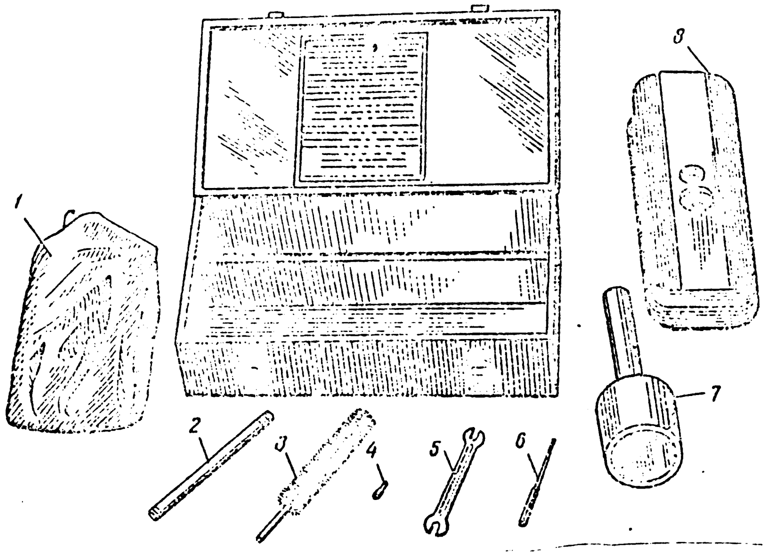
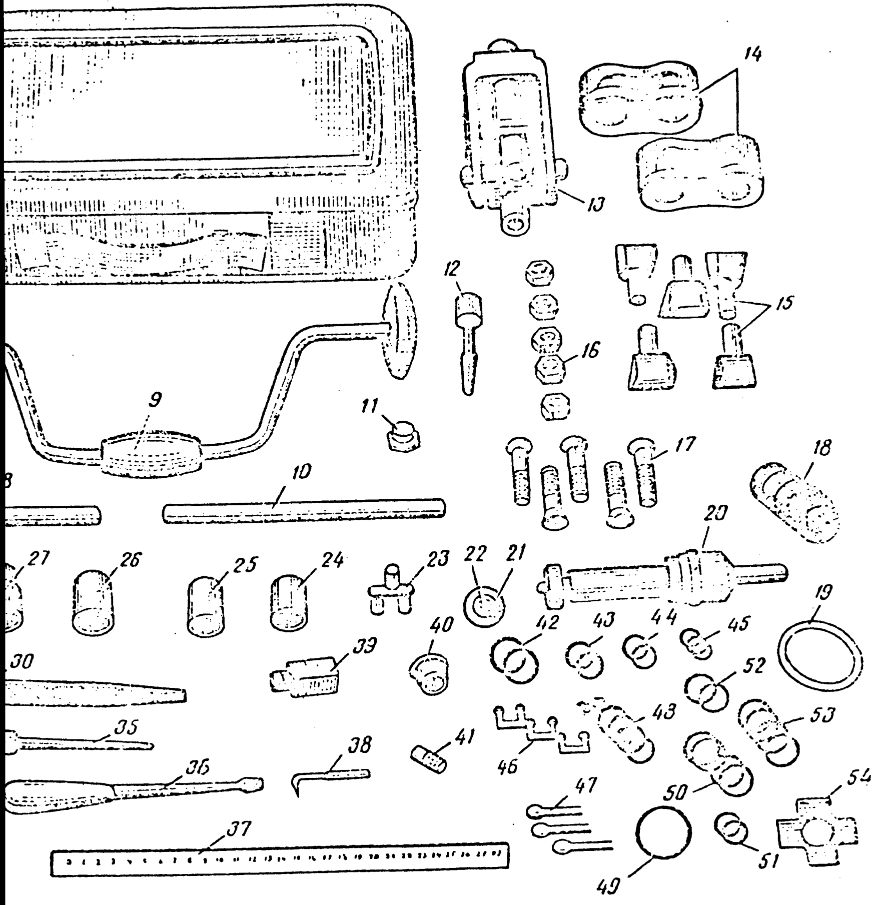


FIG.343. ARTICLES CONTAINED IN BOX FOR GUN SPTA SET AND BUOY

[redacted]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ONTAINED IN BOX FOR GENERAL-PURPOSE SPTA SET

[redacted]

[redacted]

Ref. No. in Fig.	Description	Qnty, pcs	Place of stowage
5	Wrench for nut of track adjusting mechanism	1	-
6	Extension for socket wrenches and for unscrewing the oil tank filler plug	1	-
7	Feeler gauge for checking the clearances	1	-
8	Wrench for hydraulic shock absorber plugs	1	-
9	Brace (is used in conjunction with shank and changeable heads)	1	-
10	Tommy bar for socket wrenches	1	-
11	Hexahedral plug for lubricating holes of running gear units	1	-
12	Shank for brace and changeable heads	1	-
13	Track shackle puller	1	-
14	Track shackle	2	-
15	Wedge for track	5	-
16	Nut for securing the track wedge	5	-
17	Bolt for securing the ribbed roof plate	5	-
18	Rubber diaphragm for reconditioning the reducing valve of pneumatic system	4	-
19	Rubber gasket for vacuum-and-pressure relief valve	1	-
20	Glow plug for preheater burner	1	-
21	Oil seal for water pump of preheater	1	-
22	Spring for oil seal of preheater water pump	1	-
23	Rod for checking the track tension	3	-
24	Changeable head S=17	1	-
25	Changeable head S=17 mm for drain plug of final reduction gear	1	-
26	Changeable head S=22	1	-
27	Changeable head S=19	1	-
28	Changeable head S=27 for adjusting the brake bands, for opening the vacuum-and-pressure relief valve and hull and tank plugs	1	-
29	Extension complete with funnel for filling in the coolant	1	-
30	Half-round file	1	-
31	Rubberized insulating tape for repair work	0.1 kg	-
32	Wire for locking the fastening parts	5 m	-
33	Wire for locking the fastening parts	5 m	-
34	Band for tightening the hoses	5 m	-
35	Screwdriver for device ТКН-3Б	1	-
36	Screwdriver for sight 1ПН22М1	1	-
37	Rule 1-300 for adjusting the control rods	1	-

[redacted]

[redacted]

Ref. No. in Fig.	Description	Qnty, pcs	Place of stowage
38	Cotter pin for hydraulic shock absorbers	1	-
39	Pipe union to hose of grease gun for lubricating the road wheel arm tubes	1	-
40	Plug for hydraulic shock absorbers	1	-
41	Oiler for lubricating the bridges and upper spherical supports of the hydraulic shock absorbers	1	-
42	Spring washer	2	-
43	Spring washer	2	-
44	Spring washer	2	-
45	Spring washer	3	-
46	Frame for tightening the hoses	3	-
47	Cotter pin for locking the clips	3	-
48	Fibre gasket for sealing the lubricating plugs of road wheel arm tubes	4	-
49	Copper gasket for preheater burner	1	-
50	Copper gasket for smoke-generating equipment	4	-
51	Copper-asbestos ring for sealing the fuel pipeline connections	2	-
52	Copper-asbestos ring for sealing the lubricating pipeline connections	2	-
53	Fibre gasket for sealing the lower plug of hydraulic shock absorber	4	-
54	Locking washer for running gear	1	-

Articles Contained in Driver's Tool Bag (Fig.345)

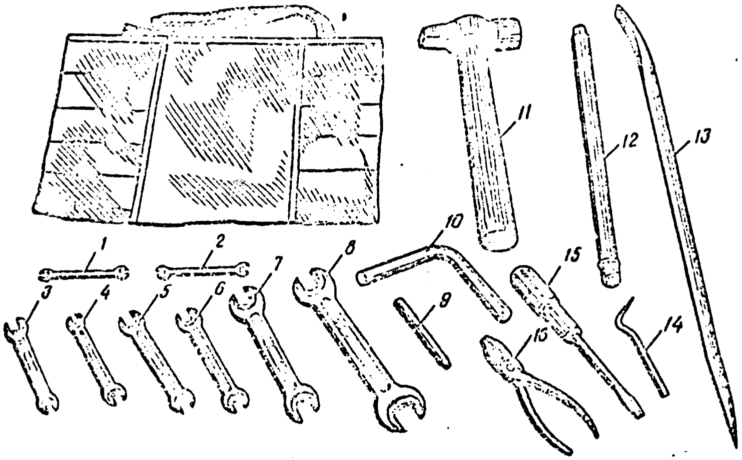

FIG.345. ARTICLES CONTAINED IN BAG FOR DRIVER'S TOOLS

[redacted]

Ref. No. in Fig.	Description	Qnty, pcs	Place of stowage
1	Flat wrench 5.5-7 mm	1	–
2	Wrench 6-8 mm	1	–
3	Wrench 10-12 mm (SPTA set for sight 1ПШ22М1)	1	–
4	Wrench 8-10 mm (SPTA set for engine)	1	–
5	Wrench 12-14 mm for adjusting the conveyer chain tension	1	–
6	Wrench 14-17 mm	1	–
7	Wrench 17-19 mm (SPTA set for engine)	1	–
8	Wrench 22-27 mm	1	–
9	Cold chisel	1	–
10	Socket wrench 10-12 mm	1	–
11	Hammer	1	–
12	Socket wrench 11-14 mm	1	–
13	Jimmy	1	–
14	Cotter pin puller	1	–
15	Screwdriver A-175x0.7 (SPTA set for engine)	1	–
16	Pliers ПК-150	1	–

Articles Contained in Bag for Engine SPTA Set (Fig.346)

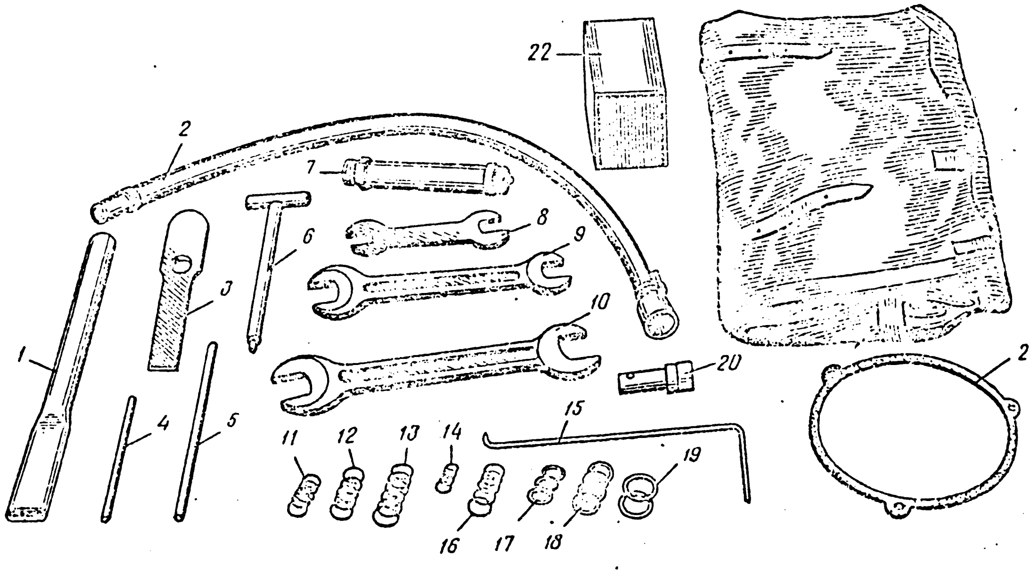

FIG.346. ARTICLES CONTAINED IN BAG FOR POWER PLANT SPTA SET

[redacted]

Ref. No. in Fig.	Description	Qnty, pcs	Place of stowage
1	Extension for wrench handles	1	-
2	Hose for plunger-type grease gun	1	-
3	Wrench for disassembly of centrifugal cleaner (SPTA set for engine)	1	-
4	Tommy bar, dia.8 (SPTA set for engine)	1	-
5	Tommy bar, dia.10 for socket wrenches (SPTA set for engine)	1	-
6	Rod of plunger-type grease gun for determining the amount of grease filled into the unit	1	-
7	Wrench for draining the oil and fuel	1	-
	Wrench 24-27 mm (engine SPTA set)	1	-
	Wrench 27-30 mm	1	-
	Wrench 32-36 mm	1	-
	Copper-asbestos ring 14-20 for sealing the air supply elbow of air distributor	5	-
12	Ring 16-22 for sealing the oil supply elbow of oil priming pump (engine SPTA set)	4	-
13	Copper-asbestos ring 18-24 for sealing the oil drain plug of cylinder block-and-crankcase unit and for sealing the joint of the pressure gauge sending unit	6	-
14	Aluminium sealing ring for sealing the elbow of pipe serving to discharge fuel-air mixture from fuel filter, while the system is primed with pump БЦН (engine SPTA set)	4	-
15	Hook for tightening the hose clips on pipelines	1	-
16	Aluminium ring for sealing the fuel inlet and outlet elbows of fuel feed pump (engine SPTA set)	6	-
17	Aluminium ring for sealing the lubricant feed elbow of fuel injection pump	3	-
18	Aluminium ring for sealing the elbow of oil supply hose of oil filter	2	-
19	Aluminium ring for sealing the fuel inlet and outlet elbows of fuel injection pump filter (engine SPTA set)	4	-
20	Socket wrench S=17 (engine SPTA set)	1	-
21	Paronite gasket for sealing the oil filter cover (engine SPTA set)	1	-
22	Set of spare parts for generator BГ-7500	1	-

[redacted]

[redacted]